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Experiments on colour aesthetics, binary combinations of colours, tints and shades.

First and second articles.

EXPERIMENTS
ON
COLOUR AESTHETICS

BINARY COMBINATIONS OF
COLOURS, TINTS AND SHADES

FIRST AND SECOND ARTICLES

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THESIS

Presented to the University of Toronto for the
Degree of Doctor of Philosophy

Frank

BY

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COLOUR AESTHETICS

COMBINATIONS OF COLOURS WITH TINTS AND WITH SHADES

BY

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COMBINATIONS OF COLOURS WITH TINTS AND WITH SHADES

The experiments reported in the following paper are a continuation and a natural supplement to those of Miss Baker and Miss Chown published in Volumes I and II. The former, Dr. Baker, has furnished most valuable results with regard to the colour harmony in binary combinations of colours of full saturation; and Miss Chown's investigation has given conclusive results with regard to the combinations of colourless light with the colours (full saturation, shades and tints). There remains then to investigate the harmony between the colours, on the one side, and the tints and shades on the other, and that between the tints and shades among themselves (T_2 with T_2, S_2 with S_2, S_2 with T_2, and T_2 with S_2). The first half of this task, i.e., the harmony between the colours and the tints and shades, is our present subject.

The experiments under discussion here were conducted in the Psychological Laboratory of the University of Toronto. The room was lighted uniformly by skylight, and the judgments were made in the afternoons at about the same time, in order to secure equal light intensity, so that as far as possible the phenomenon of Purkinje might not affect the results. Other conditions of distance from, and angle with the table, etc., were kept as uniform as possible. Upon a table with a sloping top covered with black velvet the 24 combinations were arranged in two rows, 1 to 12 and 24 to 13, no. 24 being under no. 1. Each combination consisted of two coloured cards, 83 x 33.5 mm., one colour (or its shade or tint as the case might be) being the same (constant) in all of the 24 pairs displayed at one time, the other colour (or shade or tint), called the variable, being that corresponding to the number placed above it. These variables always formed a colour-circle in uninterrupted spectral order; the combinations were 100 mm. apart. Thus it is seen that according to this method a constant would be combined with each of the 24 variables at each trial, and in a series of 24 each of the 24 constants would be combined with each of the 24 variables.

There were ten observers, varying in age and of either sex. They were asked not to consult one another regarding their results, and also to make their judgments from the immediate impression of the combinations as free as possible from distracting associations of other shapes, sizes and uses that imagination might present. Each observer completed the whole four series and recorded the numbers of the combinations found agreeable. In a second and third column were recorded those found most agreeable and unpleasant respectively.

In all experiments the constant was placed at the left of the variable, and as each constant appeared also as a variable at the right of its corresponding constant (previously a variable) each combination appears in both ways. Hence, as we combine our results the space-error is eliminated. To eliminate the time-error the order in which the constants were chosen was not that of the spectrum or any other, but they were selected at irregular intervals, so that the choices would not result from a similarity of the series with the one preceding.

Cohn used 10 colours in his experiments, giving $\frac{10 \times 9}{2} = 45$ combinations. Miss Baker and also Miss MacDougall used 24 colours, giving $\frac{24 \times 23}{2} = 276$ different pairs. Miss Chown used 24 colours with 5 greys and black and white, giving $24 \times 7 = 168$ combinations. In the present experiments the multiplier is not diminished by 1, as in Miss Baker's, on account of the colour with itself giving no binary combination. The colour with its own shade or tint gives a true combination; hence we have $24 \times 24 = 576$ in each of four series, or 2304 different combinations in all. As the number of observers is 10, and as each combination appears twice, therefore the number of judged combinations is $2304 \times 10 \times 24 = 46080$.

Tables I to IV give a condensed statement of the results. In the horizontal line of figures at the top of the table, and in the vertical line at the left, are the ordinals of the tints or shades and of the colours in full saturation, respectively. All the other numbers are cardinals, and each indicates how many times the particular colours and tints (or shades), indicated by the corresponding ordinals at the left and at the top, have been chosen. The columns at the bottom and at the right side of the tables give the totals for the tints (or shades) and for the colours respectively.

Tables I and II refer to combinations of colours and tints; Tables III and IV refer to combinations of colours and shades. Tables I and III report the "pleasant" and Tables II and IV the "most pleasant" combinations. "Unpleasant" judgments are not reported here although they are on record.

Since the tables are not easily surveyed it will be convenient to employ curves for the further discussion of the results. For this purpose a curve has been drawn for each colour, shade, and tint, analogous to those published by Miss Baker for the individual colours. Of these ninety-six diagrams we can give here only a few samples. Fig. I, for instance, deals with the combinations of colour 15 with the tints, while Fig. II refers to the combinations of tint 15 with all the colours. It may be mentioned that for other colours the difference between the curve for the colour in full saturation and that one for the tint differs sometimes more widely than in the present example. In a similar way Figs. III and IV give the curves for the combinations between colour 15 and the shades, and shade 15 and the colours. The upper curve always refers to the "pleasant," and the lower to the "most pleasant" combinations. In order to see what rôle complementarism plays in these combinations we have marked in these curves (as also in the later ones) the place of the complementary colours by a cross (+).

In Figure I, and in the corresponding diagrams for the other colours, not published here, the ordinates of the curves are an indication of the frequency with which the fully saturated colour has been chosen in combination with the tints. In these diagrams we see, just as in Miss Baker's, the unmistakable peaks in the curves for red, indicating a preference for a certain region of the colour circle, turn, in the orange and yellow, into a more indifferent plateau-like series of smaller

TABLE I.

TINTS AND COLOURS.

PLEASANT COMBINATIONS.

No. of Colours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints
1	5	7	6	6	7	8	9	10	10	9	13	10	10	9	6	3	5	4	2	2	4	1	3	3	152
2	3	4	3	6	5	7	7	7	6	7	9	9	9	6	4	3	6	3	3	2	2	0	2	2	115
3	1	6	3	5	6	6	4	5	8	8	8	8	7	5	4	5	4	3	2	1	1	2	3	4	109
4	3	6	7	7	6	5	7	5	7	7	8	6	4	6	5	4	4	4	1	1	0	3	6	2	114
5	1	2	2	4	6	9	8	4	5	4	5	4	5	6	8	6	4	4	1	2	3	2	4	2	101
6	3	4	3	7	9	10	9	6	3	5	8	5	6	10	7	7	6	7	4	5	5	7	5	5	146
7	4	6	6	6	8	9	12	8	7	5	9	4	6	10	8	8	8	10	8	5	10	9	7	7	180
8	4	4	5	8	8	9	10	7	5	9	12	8	11	11	11	9	9	7	6	7	9	10	7	7	193
9	4	3	4	6	4	5	8	8	5	7	9	8	9	10	8	7	5	11	10	7	6	6	4	5	159
10	8	5	6	8	7	5	7	5	10	10	9	8	8	7	5	3	3	9	7	8	9	6	5	7	165
11	9	6	5	8	8	7	7	9	14	11	9	7	7	4	5	6	5	5	7	6	6	5	6	8	170
12	5	7	6	8	9	7	10	10	10	10	12	11	10	7	3	4	6	6	5	8	7	6	5	8	180
13	7	7	5	10	6	7	8	9	13	12	13	12	11	12	8	5	3	7	5	7	7	7	7	8	196
14	4	2	3	3	3	7	6	7	6	10	11	12	13	14	13	11	3	8	6	9	5	6	8	6	176
15	6	6	4	8	7	7	6	6	5	4	7	8	6	13	12	9	6	8	5	8	5	7	6	7	166
16	3	2	1	3	5	6	7	6	7	5	7	4	4	13	10	11	9	5	5	3	2	1	4	2	125
17	3	2	2	5	5	3	5	6	7	5	7	6	3	6	3	8	9	6	4	7	3	1	2	2	110
18	4	1	2	4	3	6	8	8	7	7	7	6	5	7	6	6	7	6	6	8	3	2	1	1	121
19	5	2	1	3	7	6	5	4	5	8	7	4	4	8	6	5	14	11	13	11	6	4	1	1	141
20	4	1	3	5	7	6	4	5	3	8	9	7	4	7	6	3	7	11	15	12	11	8	2	1	149
21	5	3	3	7	7	7	9	8	6	5	6	5	3	6	6	5	7	6	9	14	13	7	5	2	154
22	8	6	5	7	8	7	6	6	7	5	7	9	6	7	4	6	3	0	1	1	4	10	6	9	138
23	8	6	5	6	7	9	11	10	7	6	8	6	6	7	4	4	3	4	1	1	0	5	12	8	144
24	7	7	5	5	4	6	9	9	8	5	8	6	4	7	5	6	5	2	1	3	1	3	6	6	128
Total	114	105	95	145	152	164	182	168	171	172	208	173	161	198	157	144	141	147	127	138	122	118	117	113	3532

TABLE II.

TINTS AND COLOURS.

MOST PLEASANT COMBINATIONS.

No. of Colours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints
1	2	2	3	2	1	0	2	0	0	2	3	5	3	1	2	2	1	1	1	1	2	1	1	1	39
2	1	2	0	3	2	0	1	1	0	2	3	3	2	1	1	2	3	1	1	1	1	0	1	2	34
3	0	2	1	3	2	1	2	2	1	2	4	4	2	1	1	1	1	0	0	0	0	0	1	3	34
4	0	1	3	4	1	0	2	2	1	2	1	3	1	2	1	2	1	0	0	0	0	0	3	2	32
5	0	1	2	2	2	4	1	2	0	2	2	3	1	2	2	2	1	0	1	1	2	2	2	1	38
6	1	2	2	2	2	4	4	0	0	0	3	0	2	2	2	3	1	0	1	0	3	1	1	2	38
7	1	1	3	4	2	4	6	3	2	0	3	1	2	4	3	1	1	1	0	1	4	3	3	2	55
8	0	1	1	3	2	4	3	1	1	3	3	3	1	6	4	3	2	1	1	1	2	4	1	1	52
9	0	0	0	2	2	3	2	4	1	1	2	2	2	4	4	3	0	1	1	2	3	1	2	4	46
10	3	0	1	3	4	3	2	2	3	3	2	2	4	2	1	0	0	4	2	3	5	2	3	3	57
11	4	2	1	3	2	3	0	1	6	3	2	2	2	1	2	3	1	2	2	3	4	1	2	3	55
12	1	2	2	3	3	3	2	3	4	3	5	6	3	1	1	1	1	3	2	4	2	0	4	4	63
13	2	0	0	0	1	1	2	2	0	2	5	7	7	1	4	1	1	1	1	3	3	1	2	1	48
14	2	0	1	1	1	1	1	2	1	2	5	6	8	7	7	3	1	1	2	4	2	3	1	1	63
15	1	2	0	1	1	3	2	0	1	2	1	0	2	5	6	5	1	2	1	0	1	2	4	4	47
16	1	1	0	1	0	1	1	2	1	1	4	0	1	3	1	7	3	1	1	1	0	0	0	0	31
17	1	0	0	2	0	1	1	1	1	2	1	0	1	1	0	2	6	4	0	1	1	0	1	1	28
18	0	0	0	2	2	1	2	2	2	2	3	3	1	1	2	3	3	3	3	1	0	1	0	1	38
19	0	0	0	0	1	1	1	1	1	2	1	0	1	1	1	1	5	5	6	4	1	1	1	1	36
20	0	0	1	2	3	2	1	0	1	0	0	1	1	0	0	0	3	5	7	8	8	4	0	1	48
21	1	0	0	1	1	0	2	1	1	1	0	1	1	1	0	1	2	3	3	9	10	5	1	0	45
22	3	1	1	1	1	0	1	2	1	1	2	3	1	2	1	1	2	0	1	0	0	4	5	8	42
23	3	3	1	1	3	2	3	1	2	2	2	4	1	2	0	0	0	0	0	0	0	1	5	4	40
24	1	0	0	3	2	2	2	3	3	4	2	1	0	4	1	1	3	0	0	0	0	1	2	4	39
Total	28	23	23	49	41	46	46	38	34	44	59	60	50	55	47	48	43	39	37	48	54	38	46	54	1048

TABLE III.

SHADES AND COLOURS.

PLEASANT COMBINATIONS.

No. of Colours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Shades
1	4	5	6	7	7	9	10	7	11	9	12	8	9	12	9	8	7	8	7	7	6	4	3	4	179
2	6	7	5	8	5	9	9	10	10	7	9	7	7	7	5	4	8	5	4	4	7	6	5	5	159
3	9	6	7	8	10	12	11	12	8	8	10	7	7	4	5	4	5	5	5	3	6	5	4	5	166
4	6	6	5	7	9	11	9	10	8	8	6	7	9	6	4	3	4	2	6	4	8	5	4	7	154
5	8	6	6	9	12	15	8	12	10	8	7	4	8	6	4	6	6	4	7	5	8	6	7	5	177
6	12	14	9	10	14	13	14	12	9	11	11	11	8	6	5	7	8	8	10	8	8	8	13	9	238
7	10	13	10	13	14	15	13	11	11	13	10	9	6	5	6	8	8	6	8	6	10	12	10	8	235
8	13	11	8	8	8	9	14	9	11	12	6	9	11	8	9	5	9	8	6	5	6	5	7	8	205
9	8	5	4	5	4	10	7	10	6	7	6	5	7	6	6	5	7	6	6	7	7	4	4	5	147
10	5	8	9	8	6	8	8	9	9	7	7	4	6	5	6	4	7	5	6	5	5	5	6	6	154
11	11	11	8	10	8	10	9	9	8	10	12	8	10	9	5	6	6	6	4	8	6	8	7	10	199
12	8	7	6	9	6	9	12	10	7	6	7	6	9	4	7	6	7	7	6	7	6	10	14	11	187
13	9	9	7	7	7	10	10	7	8	7	9	5	7	5	6	10	7	8	4	5	3	5	11	9	175
14	10	6	6	7	6	9	9	7	7	11	7	8	8	7	5	6	7	8	5	8	6	4	7	9	173
15	7	3	6	10	7	8	8	7	7	6	3	6	4	4	2	4	4	6	3	4	4	4	7	6	130
16	8	3	8	8	3	7	9	8	8	6	6	6	7	8	4	3	2	4	1	1	3	1	3	3	120
17	5	5	8	6	8	7	7	8	7	3	5	4	4	5	3	4	4	5	3	0	2	2	3	2	110
18	5	2	4	6	5	5	4	7	7	1	7	6	5	6	4	2	6	6	6	2	3	3	3	3	108
19	7	2	5	5	3	5	5	5	7	4	4	7	7	4	4	3	3	6	5	2	2	2	2	4	103
20	4	4	4	5	6	10	9	2	6	5	6	6	12	7	6	4	3	4	9	4	3	2	3	5	129
21	4	5	5	6	5	6	6	5	2	4	5	5	7	7	4	3	3	5	7	6	7	3	3	4	117
22	4	6	5	4	8	10	12	11	10	10	9	11	9	9	10	6	4	4	7	6	7	8	9	6	185
23	4	6	3	5	5	7	10	14	10	7	9	8	6	9	9	7	7	5	7	5	6	4	7	5	165
24	4	7	6	8	10	10	11	14	7	6	8	10	12	11	9	7	6	9	7	7	5	5	5	6	190
Total	171	157	150	179	176	224	224	216	194	176	181	167	185	160	137	125	138	140	139	119	134	121	147	145	3905

TABLE IV.

SHADES AND COLOURS.

MOST PLEASANT COMBINATIONS.

No. of Colours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Shades
1	2	3	0	5	2	4	2	2	3	3	4	1	4	6	3	1	2	3	2	2	1	1	2	3	61
2	2	3	1	3	1	1	2	0	3	3	5	1	2	2	1	0	0	1	1	1	2	2	2	3	42
3	3	2	2	3	4	4	4	3	1	2	2	3	3	2	0	1	0	1	1	0	2	1	0	0	44
4	4	2	1	2	2	3	4	2	1	1	2	3	4	2	3	1	1	0	0	0	0	0	0	2	40
5	4	2	1	4	3	2	3	2	1	4	1	1	1	1	2	2	1	0	0	0	0	2	1	1	39
6	4	4	4	6	3	4	5	4	2	3	3	2	1	0	1	3	2	3	1	0	0	2	2	1	60
7	2	5	6	3	3	6	9	4	3	3	3	0	1	0	1	3	1	0	2	0	3	4	3	2	67
8	3	3	2	1	2	3	3	4	3	2	2	2	1	3	2	4	2	3	1	2	4	1	3	3	59
9	1	1	0	0	0	2	2	3	0	2	1	1	4	2	2	3	3	5	1	2	2	1	2	3	43
10	2	1	3	5	1	2	5	4	6	4	5	2	2	1	1	0	3	2	1	3	2	2	2	2	61
11	8	5	4	3	2	1	3	2	4	2	5	5	3	0	1	1	2	1	3	3	1	5	4	6	74
12	4	6	2	2	1	0	4	2	2	2	3	2	3	1	3	3	1	2	1	1	2	2	8	4	61
13	0	5	3	1	2	3	3	1	0	2	3	3	2	1	4	5	2	0	0	0	0	2	1	2	45
14	5	3	1	5	4	4	3	2	2	5	4	3	4	5	3	2	1	5	3	3	2	2	6	4	81
15	1	1	1	3	1	2	5	2	2	2	2	4	1	2	1	1	0	0	0	1	2	0	2	1	37
16	0	0	1	1	1	1	5	3	3	4	2	2	1	4	2	1	1	0	0	0	1	0	1	1	35
17	1	1	2	0	2	2	5	4	4	2	0	2	0	2	1	1	1	3	0	0	0	0	0	1	34
18	1	0	0	1	2	1	2	5	4	1	1	0	2	2	0	1	2	0	2	0	0	0	0	1	28
19	1	0	0	1	1	0	2	1	3	0	1	2	3	1	0	1	1	2	2	2	1	1	1	0	27
20	1	1	1	1	1	3	3	0	1	1	0	1	3	3	0	0	2	2	2	3	1	1	0	0	31
21	1	0	0	1	1	2	0	1	0	1	1	1	2	1	1	0	1	2	1	2	4	1	1	2	27
22	2	1	0	1	3	5	3	4	5	1	3	4	4	4	4	0	1	2	1	1	2	3	2	4	60
23	3	0	2	1	0	5	4	5	5	3	3	4	2	5	3	2	1	2	3	1	2	2	1	3	62
24	2	0	0	2	4	2	3	5	3	2	1	2	2	6	1	1	1	3	3	2	2	1	2	3	53
Total	57	49	37	55	46	62	84	65	61	55	57	51	55	56	40	37	32	42	31	29	36	36	40	52	1171

TABLE V.

TINTS AND COLOURS.

PLEASANT COMBINATIONS.

A.

Colours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints
Red.......	9	17	12	17	18	21	20	22	24	24	30	27	26	20	14	11	15	10	7	5	7	3	8	9	
Orange....	7	12	12	18	21	24	24	15	15	16	21	15	15	22	20	17	14	15	6	8	8	12	15	7	
Yellow....	12	13	15	20	20	23	30	23	17	21	30	20	26	31	27	24	22	28	24	19	25	25	18	19	
Yel.-Green	22	18	17	24	24	19	24	24	34	31	30	26	25	18	13	13	14	20	19	22	22	17	16	23	
Blue Green	17	15	12	21	16	21	20	22	24	26	31	32	30	39	33	25	12	23	16	24	17	20	21	21	
Blue......	10	5	5	12	13	15	20	20	21	17	21	16	12	26	19	25	25	17	15	18	8	4	7	5	
Violet.....	14	6	7	15	21	19	18	17	14	21	22	16	11	21	18	13	28	28	37	37	30	19	8	4	
Purple.....	23	19	15	18	19	22	26	25	22	16	23	21	16	21	13	16	11	6	3	5	5	18	24	23	

B.

Tints	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Colours
Red.......	18	10	10	16	5	10	16	13	11	19	20	18	19	9	16	6	7	7	8	8	11	19	19	19	
Orange....	21	18	17	18	19	26	23	25	15	20	23	24	23	13	22	14	13	13	16	18	21	22	22	15	
Yellow....	29	20	17	19	17	18	27	22	21	22	30	30	30	19	17	20	18	23	14	12	23	19	28	26	
Yel..Green	32	25	24	21	13	18	18	29	24	27	27	33	37	33	19	16	18	20	19	24	16	21	20	19	
Blue-Green	25	19	16	15	19	23	24	33	27	20	16	20	31	40	31	27	12	18	18	17	15	17	17	16	
Blue......	12	12	12	12	14	20	26	25	23	15	16	16	15	22	28	25	23	19	30	21	18	9	11	13	
Violet..	8	7	4	2	6	14	23	22	23	24	19	20	19	20	18	10	14	17	30	38	36	6	2	5	
Purple.....	7	4	9	11	8	17	23	24	15	18	19	19	22	20	20	7	5	4	6	11	14	25	25	15	

TABLE VI.

TINTS AND COLOURS.

MOST PLEASANT COMBINATIONS.

A.

Colours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints
Red.......	3	6	4	8	5	1	5	3	1	6	10	12	7	3	4	5	5	2	2	2	3	1	3	6	
Orange....	1	4	7	8	5	8	7	4	1	4	6	6	4	6	5	7	3	0	2	1	5	3	6	5	
Yellow....	1	2	4	9	6	11	11	8	4	4	8	6	5	14	11	7	3	3	2	4	9	8	6	7	
Yel.-Green.	8	4	4	9	9	9	4	6	13	9	9	10	9	4	4	4	2	9	6	10	11	3	9	10	
Blue-Green	5	2	1	2	3	5	5	4	2	6	11	13	17	13	17	9	3	4	4	7	6	6	7	6	
Blue......	2	1	0	5	2	3	4	5	4	5	8	3	3	5	3	12	12	8	4	3	1	1	1	2	
Violet.....	1	0	1	3	5	3	4	2	3	3	1	2	3	2	1	2	10	13	16	21	19	10	2	2	
Purple.....	7	4	2	5	6	4	6	6	6	7	6	8	2	8	2	2	5	0	1	0	0	6	12	16	

B.

Tints	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Colours
Red.......	7	3	3	4	3	5	5	2	0	4	7	5	2	3	3	2	1	0	0	1	1	5	7	1	
Orange....	3	5	6	5	8	8	10	9	7	10	8	9	2	3	5	2	3	5	2	7	2	2	6	7	
Yellow....	2	2	5	5	3	4	11	5	7	7	7	9	4	4	3	4	3	6	3	2	4	4	6	8	
Yel.-Green	10	8	10	6	7	3	4	9	5	7	7	14	14	13	3	5	3	8	3	1	2	6	8	7	
Blue-Green	6	4	4	4	5	6	9	11	10	7	5	5	12	22	13	5	2	4	3	1	2	4	3	5	
Blue......	4	6	2	3	3	4	3	6	4	4	6	5	3	5	8	11	12	9	11	8	6	3	0	4	
Violet.....	4	3	0	0	4	4	5	4	6	10	9	8	7	8	2	2	2	4	11	23	22	1	0	0	
Purple.....	3	3	4	5	5	4	8	6	7	8	6	8	4	5	10	0	2	2	3	5	6	17	10	7	

TABLE VII.

SHADES AND COLOURS.

PLEASANT COMBINATIONS.

A.

Colours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Shades
Red.......	19	18	18	23	22	30	30	29	29	24	31	22	23	23	19	16	20	18	16	14	19	15	12	14	
Orange ...	26	26	20	26	35	39	31	34	27	27	24	22	25	18	13	16	18	14	23	17	24	19	24	21	
Yellow....	31	29	22	26	26	34	34	30	28	32	22	23	24	19	21	18	24	20	20	18	23	21	21	21	
Yel.-Green	24	26	23	27	20	27	29	28	24	23	26	18	25	18	18	16	20	18	16	20	17	23	27	27	
Blue-Green..	26	18	19	24	20	27	27	21	22	24	19	19	19	16	13	20	18	22	12	17	13	13	25	24	
Blue......	18	10	20	20	16	19	20	23	22	10	18	16	16	19	11	9	12	15	10	3	8	6	9	8	
Violet.....	15	11	14	16	14	21	20	12	15	13	15	18	26	18	14	10	9	15	21	12	12	7	8	13	
Purple.....	12	19	14	17	23	27	33	39	27	23	26	29	27	29	28	20	17	18	21	18	18	17	21	17	

B.

Shades	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Colours
Red.......	15	18	22	17	20	35	33	32	17	22	30	21	25	22	16	19	18	11	14	12	14	15	13	17	
Orange....	23	22	30	27	36	37	42	25	19	22	28	24	24	22	25	18	21	16	13	21	17	22	17	28	
Yellow....	28	29	31	27	30	35	35	34	23	26	26	29	25	23	22	25	22	18	17	17	13	33	34	32	
Yel.-Green	29	23	25	21	19	33	32	27	18	18	30	19	21	26	15	18	12	14	15	17	14	30	24	24	
Blue-Green	30	19	16	19	18	19	17	28	19	17	24	20	18	20	10	19	12	15	15	25	18	28	24	32	
Blue......	23	17	14	9	16	23	22	22	18	16	18	20	25	21	14	9	13	14	12	11	11	14	19	22	
Violet.....	20	15	14	18	20	26	24	17	20	16	18	19	12	19	11	5	5	11	9	16	20	20	18	19	
Purple.....	11	16	14	16	18	30	30	20	13	17	25	35	25	20	17	7	7	9	8	10	10	23	16	16	

TABLE VIII.

SHADES AND COLOURS.

MOST PLEASANT.

A.

Colours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 Shades
Red.......	7	8	3	11	7	9	8	5	7	8	11	5	9	10	4	2	2	5	4	3	5	4	4	6
Orange....	12	8	6	12	8	9	12	8	4	8	6	6	6	3	6	6	4	3	1	0	0	4	3	4
Yellow....	6	9	8	4	5	11	14	11	6	7	6	3	6	5	5	10	6	8	4	4	9	6	8	8
Yel.-Green.	14	12	9	10	4	3	12	8	12	8	13	9	8	2	5	4	6	5	5	7	5	9	14	12
Blue-Green...	6	9	5	9	7	9	11	5	4	9	9	10	7	8	8	8	3	5	3	4	4	4	9	7
Blue......	2	1	3	2	5	4	12	12	11	7	3	4	3	8	3	3	4	3	2	0	1	0	1	3
Violet.....	3	1	1	3	3	5	5	2	4	2	2	4	8	5	1	1	4	6	5	7	6	3	2	2
Purple.....	7	1	2	4	7	12	10	14	13	6	7	10	8	15	8	3	3	7	7	4	6	6	5	10

B.

Shades	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 Colours
Red.......	5	6	7	7	7	12	13	8	2	6	17	12	8	9	3	1	4	1	1	3	1	3	5	2
Orange....	11	5	11	7	9	13	12	6	2	8	6	3	6	13	6	3	4	4	2	5	4	9	6	8
Yellow....	7	5	8	7	6	11	16	10	5	15	9	8	4	7	9	11	13	11	6	4	1	12	14	11
Yel.-Green.	8	9	7	6	6	8	6	6	4	11	12	7	8	12	8	8	4	2	3	2	3	8	10	5
Blue-Green	13	5	5	9	4	2	2	6	8	4	4	7	7	12	4	7	3	4	4	6	4	12	10	9
Blue......	6	1	2	2	3	8	4	9	11	5	4	6	7	8	1	2	5	3	4	4	3	3	5	5
Violet.....	5	4	3	0	0	1	5	7	5	6	7	4	0	8	3	1	0	2	5	6	7	4	6	7
Purple.....	6	7	1	2	4	5	9	7	6	6	15	14	5	12	3	2	1	1	2	1	4	9	6	6

maxima distributed over the whole field. The maximum never coincides with the complementary colour. The latter is sometimes even very near the minimum. But in a few cases also it is at a minor maximum.

In one sense the curves are not comparable with those of Miss Baker's, where the colour could never be combined with itself, whilst in our experiments the colour combined with a shade or a tint of itself might make a very good combination. So we see, for instance, that the purples and reddish-purples, which, as everybody knows, are so difficult to match, have their maximum with themselves or their nearest neighbours, and a second maximum with yellow or greenish-yellow. Of course, Miss Baker's curves could show no such thing, as the colours combined with themselves would make no binary combination at all.

In the curves of which Figure II is a sample the frequency of the selection of a tint with the colours is shown. Of course, it must by no means be expected that the curves closely correspond to those of the foregoing series—though they may show similar features, in so far as the colour *quality* is concerned. Thus, for instance, we make the same observation as regards the non-coincidence of maximum and complementary, and we observe again the above mentioned relations of the purple with itself and yellow.

Tints.	Harmonize best with	Harmonize with	Do not harmonize with	
Red..........	Yellow-green...	Violet-purple.....	Blue and Violet.	Colours in full saturation
Orange..........	Green........	Themselves......	Blue.	
Yellow and Yellow-green.	Themselves...	Yellow-green.....	Blue.	
Green.........	Red..........	Themselves......	Orange, Blue.	
Blue..........	Themselves...	Their neighbours..	Green, Red.	
Violet.........	Themselves...	Yellow..........	Red, Blue.	
Purple.........	Themselves...	Yellow..........	Red, Violet.	

The third series of curves of which Figure III is a specimen shows the harmonic qualities of colours in relation to the shades. Complementarism does not seem to be favoured except in the green and the blue, and partially so in the purple. Here there are sometimes several maxima, which for the red colour are always in the yellow or yellow-green. The orange and yellow colours have their maxima decidedly with their own shades or with those of near neighbours—a circumstance which might well be expected from the frequency with which, for ornamental purposes in rooms, architecture, etc., we use the combinations of different shades of yellow or orange (brown). As soon as we come toward the green, however, the maximum jumps to the purple, and for the colours 12 and 13 we have the rare case where the maximum closely coincides with the complementary. Thus, while complementary green and purple do not form the most agreeable combination when in full saturation,[1] they do so when the purple is a shade. Similarly we find a maximum for the purple colours (22, 23, 24) in the green (11, 12, 13), though in this case the yellow has still a little greater preference. While we observed that the purple colours harmonize very well with their own tints, we cannot say the same with regard to their relation to their own shades; on the contrary, their own shades are decidedly in the minimum.

Figure IV is an example of the fourth set of curves which indicate the frequency with which the shades were chosen in combination with the colours. Here we make the same observations with regard to the green. It seems to harmonize best with the purple, though in no case is the complementary directly in the maximum. The maxima fall as follows :—

Red	with	Yellow
Orange (Or.-Yellow)	"	Orange-Yellow.
Yellow	"	Purple and Orange.
Yellow-green	"	Orange-yellow.
Bluish-green	"	Purple.
Green	"	Orange-yellow and Purple.
Blue	"	Yellow and Green, and the minimum with itself.
Violet	"	Violet-purple and Yellow.
Purple	"	Yellow and Green.

---

[1] See Miss Baker's Curves.

What has been stated with reference to the 96 curves of which we could only give four examples will appear equally clear in the following plates, containing Figures V to XX.

These curves correspond to some extent to the combination curves XXV to XXXVI in Miss Baker's first article. In these curves three qualities are always combined, thus, Red stands for one, two and three, Orange for four, five and six, Yellow for seven, eight and nine, Yellow-green for ten, eleven and twelve, Blue-green for thirteen, fourteen and fifteen, Blue for sixteen, seventeen and eighteen, Violet for nineteen, twenty and twenty-one, Purple for twenty-two, twenty-three and twenty-four. The numbers for the ordinates of these curves will be found in Tables v, vi, vii and viii.

Each figure contains four curves, the upper referring to "pleasant" and the lower to "most pleasant" combinations. In Figure V the plain curves refer to the combinations of the tints with the fully saturated red (1, 2, 3); the dotted curves on the other hand represent the combinations of the fully saturated colours with the tint of red (1, 2, 3). The other figures are arranged similarly.

Figures XXI and XXII give the grand total or summation curves. In the former the results of the combinations of colours and tints are represented, whilst the latter refers to colours and shades. Analogous to the foregoing figures the *plain* curves show the degree of harmonizing power of the colours in full saturation, whilst the *dotted* curves indicate the harmonizing capability of the shades and tints. In these curves the striking difference in the behaviour of shades and tints manifests itself at once. For combinations of tints and colours there is a broad maximum in the middle of the spectrum, in the yellow, yellow-green and blue-green. From there the harmonizing power of the tints slopes more or less abruptly down toward the spectral ends, whilst for the colours in combination with tints there are secondary maxima in violet and red, thus leaving the orange and the blue in a decided, and the purple in a less pronounced minimum. The curve for the "most pleasant" combinations forms in each case almost a copy of that for the pleasant on a smaller scale.

The pleasant curves for the "shades and colours" show a most decided maximum in the orange-yellow and secondary maxima in the green and purple. The deepest drop appears in the blue and violet. This minimum and the secondary maxima are more pronounced for the colours than for the shades. The "most pleasant" curve corresponds well with the "pleasant" in case of the shades, whilst for the colours there are three pointed maxima in the orange-yellow, the yellow-green and the blue-green, the latter being the highest, with decided drops between them.

The summation curves as well as the grand totals of Tables i to iv show that in combination with fully saturated colours shades have a considerable advantage over tints. The pleasant combinations of shades and colours exceed those of tints and colours by 373 which is about 10 per cent., whilst for the most pleasant combinations a corresponding excess of 123 is observed, which amounts to almost 12 per cent.

In Tables ix, x, xi, xii we give a more condensed and consequently a more perspicuous representation of our results. The grouping together of three consecutive qualities is applied here to both sides,—to the colours as well as to the tints and shades. Hence it is quite easy to survey the 64 fields of the tables. Thus, for instance, in Table ix the first horizontal row of numbers indicates that the power of harmonization of red with the tints of the eight qualities is greatest for yellow-green, less great for yellow and for blue-green, still less for orange, red, blue and purple and smallest for violet.

The first vertical column, on the other hand, shows that the tint of red when combined with the colours in full saturation harmonizes equally well with yellow-green and purple, somewhat less with blue-green, yellow and red, still less with orange and violet and least with blue. So with the other columns. From the whole table one can see that with regard to the combination of *tints* and colours the gravitation of pleasantness is to the middle of the spectrum; whilst from Table xi it can easily be deduced that the gravity centre for pleasantness for *shades* and colours is decidedly with the "warm" colours (orange and yellow). The question in how far the colours agree with their own tints and shades can also be settled by these tables., The best to agree with their own tints, as Table ix shows, are blue-green and violet, next comes yellow-green, then yellow, blue, purple, and the least, red. A glance at Table x shows that the same result can be ascertained from the "most pleasant" judgments. Tables xi and xii show that it is quite different with regard to shades. The colours which agree best with their own shades are orange and yellow.

TABLE IX.

TINTS AND COLOURS.—"PLEASANT."

Colours.	R.	Or.	Y.	Y.G.	B.	B.G.	V.	P.	Tints.
R..........	38	56	66	81	60	36	19	20	376
Or..........	31	63	54	52	57	46	22	36	361
Y..........	40	63	70	71	84	74	68	62	532
Y.G..........	57	67	82	87	56	47	63	56	515
B.G..........	44	58	66	89	102	60	57	62	538
B..........	20	40	61	54	57	67	41	16	356
V..........	27	55	49	59	50	69	104	31	444
P..........	57	59	73	60	50	33	13	65	410
	314	461	521	553	516	432	387	348	3532

TABLE X.

TINTS AND COLOURS.—" MOST PLEASANT."

Colours.	R.	Or.	Y.	Y.G.	B.G.	B.	V.	P.	Tints.
R..........	13	14	9	28	14	12	7	10	107
Or..........	12	21	12	16	15	10	8	14	108
Y..........	7	26	23	18	30	13	15	21	153
Y.G..........	16	27	23	28	17	15	27	22	175
B.G..........	8	10	11	30	47	16	17	19	158
B..........	3	10	13	16	11	32	8	4	97
V..	2	11	9	6	6	25	56	14	129
P..........	13	15	18	21	12	7	1	34	121
	74	134	118	163	152	120	139	148	1048

TABLE XI.

SHADES AND COLOURS.—" PLEASANT."

Colours.	R.	Or.	Y	Y.G.	B.G.	B.	V.	P.	Shades
R..........	55	75	88	77	65	54	49	41	504
Or.........	72	100	92	73	56	48	64	64	569
Y..........	82	86	92	77	64	62	61	63	587
Y.G........	73	74	81	67	61	54	53	77	540
B.G........	63	71	70	62	48	60	42	62	478
B..........	48	55	65	44	46	36	21	23	338
V..........	40	51	47	46	58	34	45	28	349
P..........	45	67	99	78	84	55	57	55	540
	478	579	634	524	482	403	392	413	3905

TABLE XII.

SHADES AND COLOURS.—" MOST PLEASANT."

Colours.	R.	Or.	Y.	Y.G.	B.G.	B.	V.	P.	Shades
R..........	18	27	20	24	23	9	12	14	147
Or.........	26	29	24	20	15	13	1	11	139
Y..........	23	20	31	16	16	24	17	22	169
Y.G........	35	17	32	30	15	15	17	35	196
B.G........	20	25	20	28	23	16	11	20	163
B..........	6	11	35	14	14	10	3	4	97
V..........	5	11	11	8	14	11	18	7	85
P..........	10	23	37	23	31	13	17	21	175
	143	163	210	163	151	111	96	134	1171

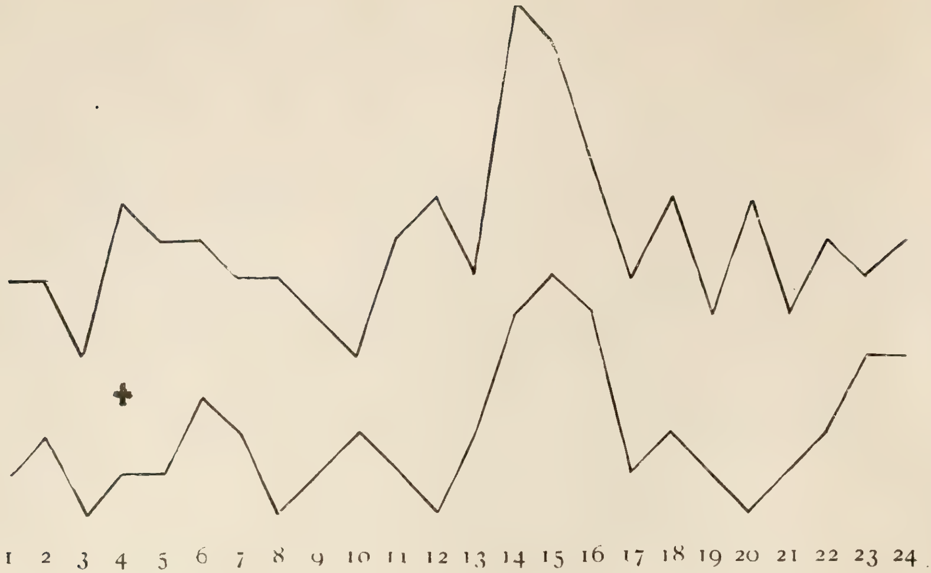

Fig. I.—Colour 15 with Tints

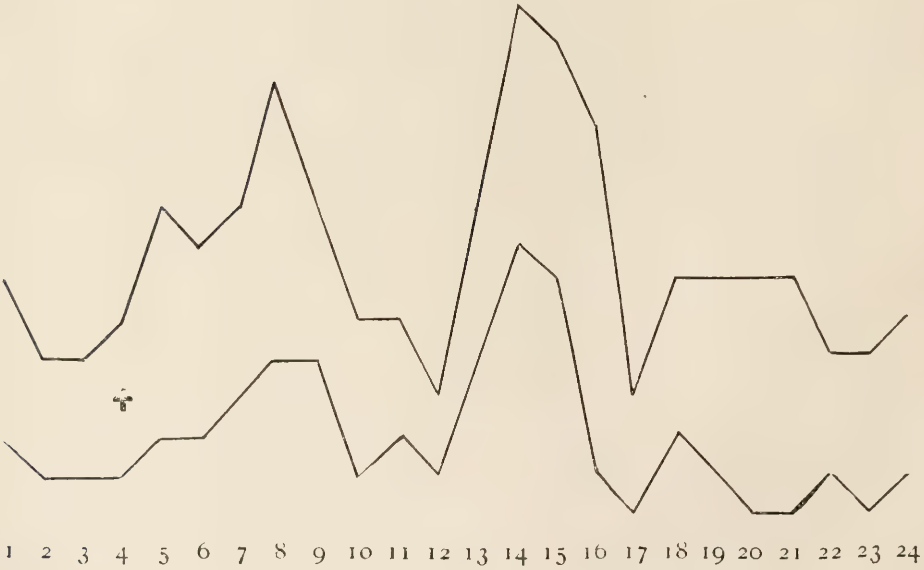

Fig. II.—Tint 15 with Colours

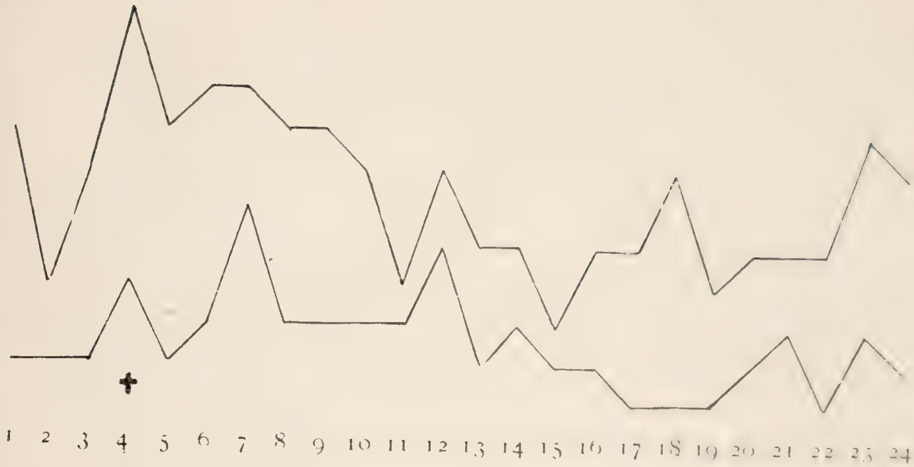

FIG. III.—COLOUR 15 WITH SHADES

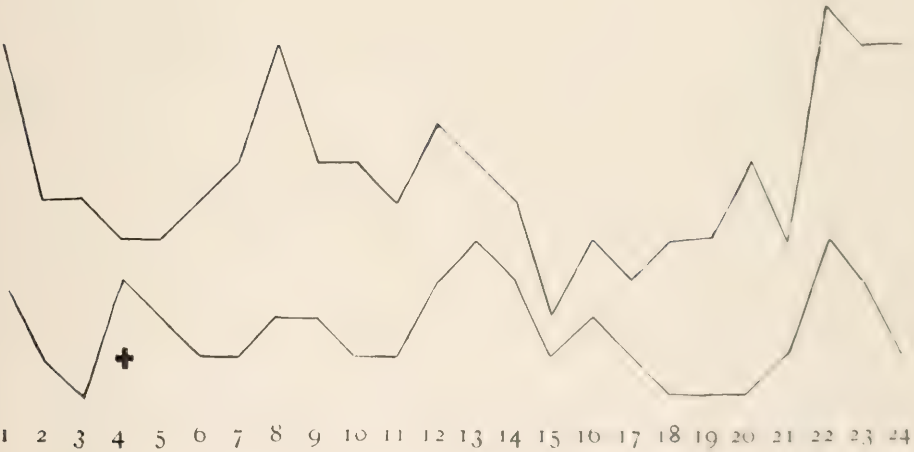

FIG. IV.—SHADE 15 WITH COLOURS

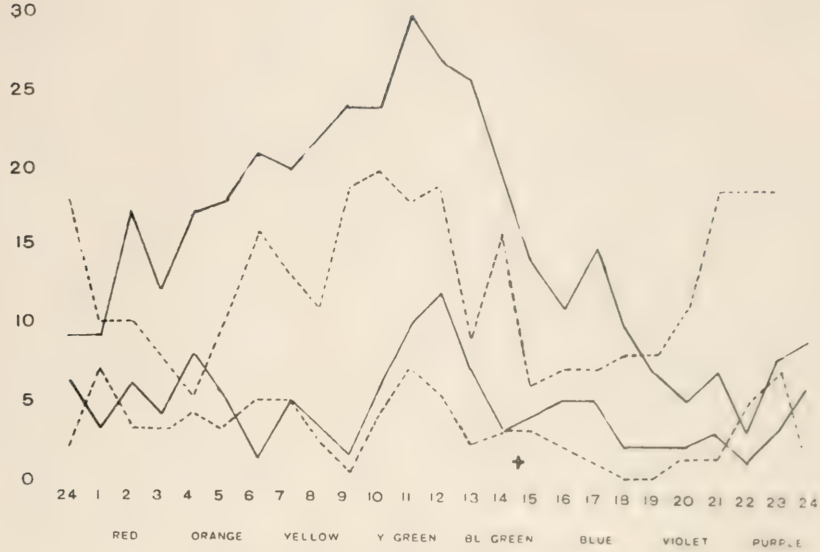

FIG. V.—RED, TINTS AND COLOURS

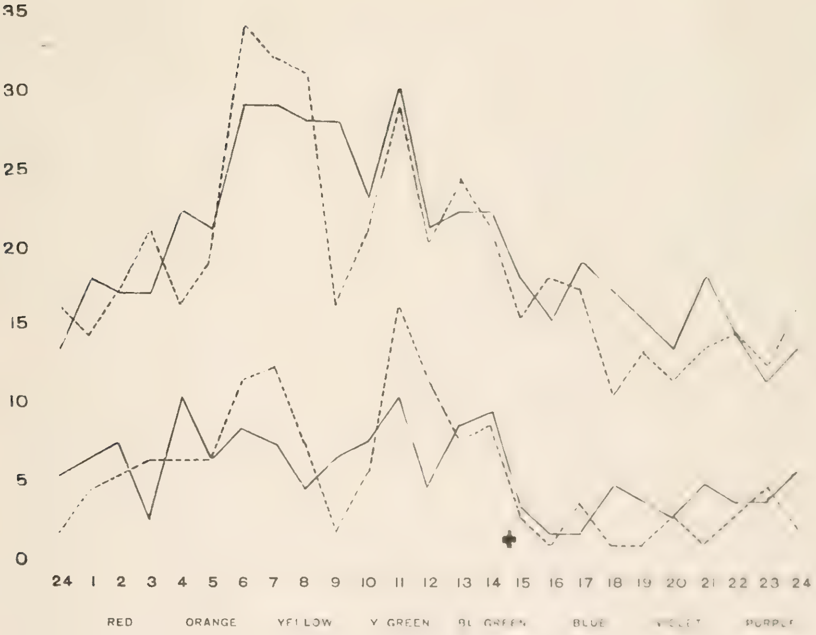

FIG. VI.—RED, SHADES AND COLOURS

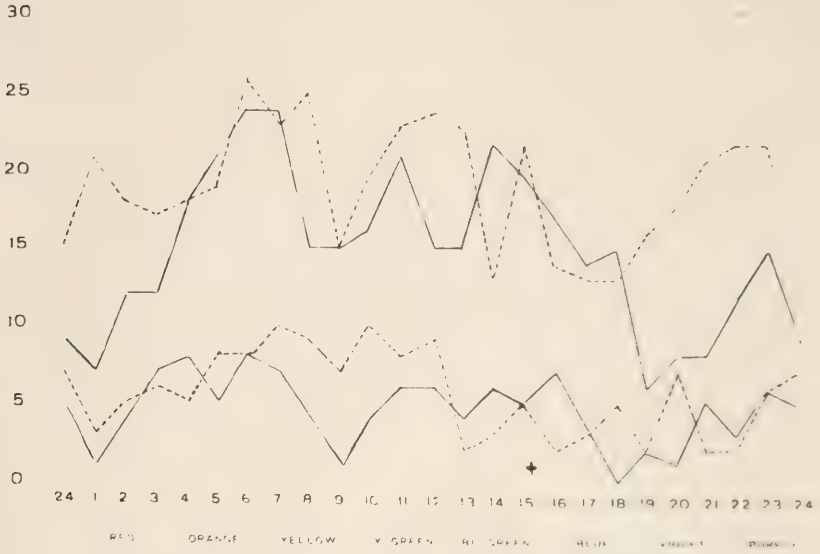

FIG. VII.—ORANGE, TINTS AND COLOURS

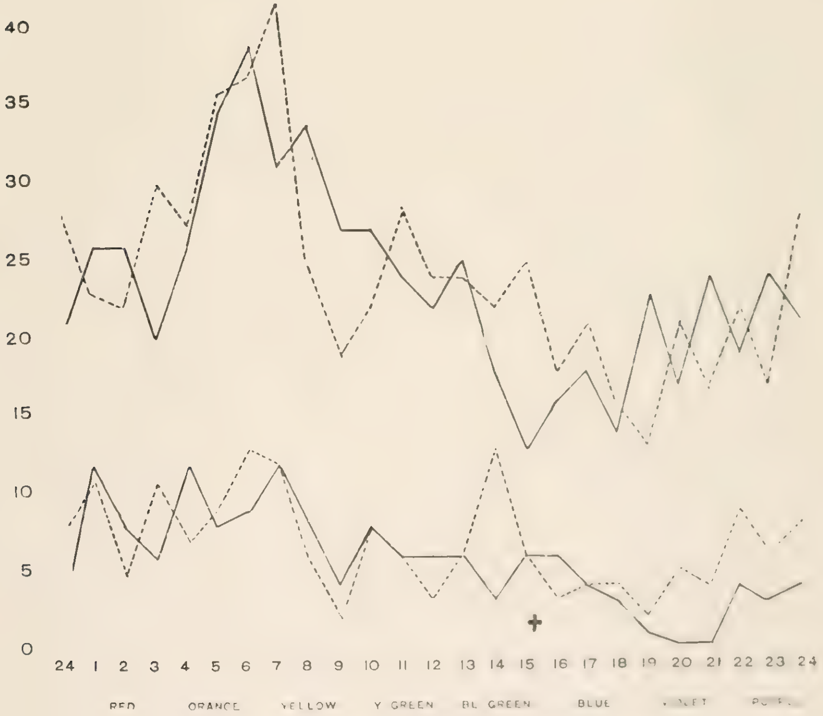

FIG. VIII.—ORANGE, SHADES AND COLOURS

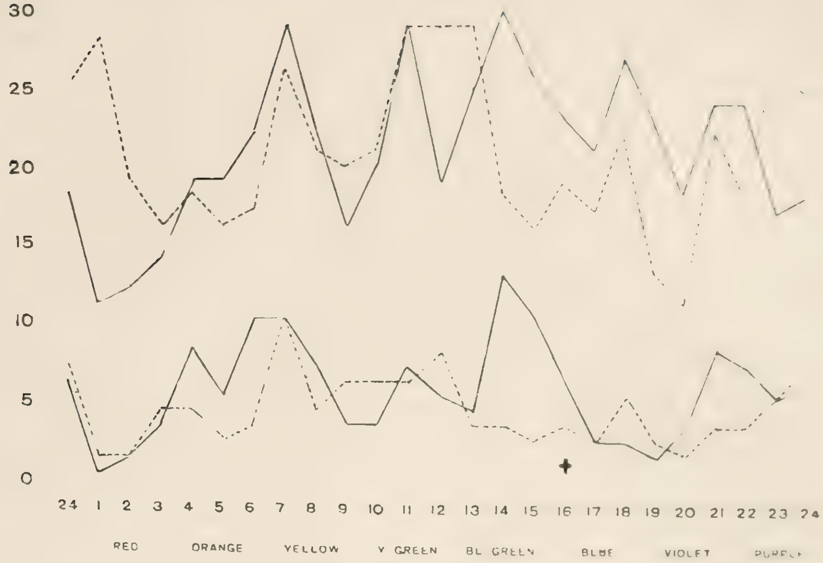

FIG. IX.—YELLOW, TINTS AND COLOURS

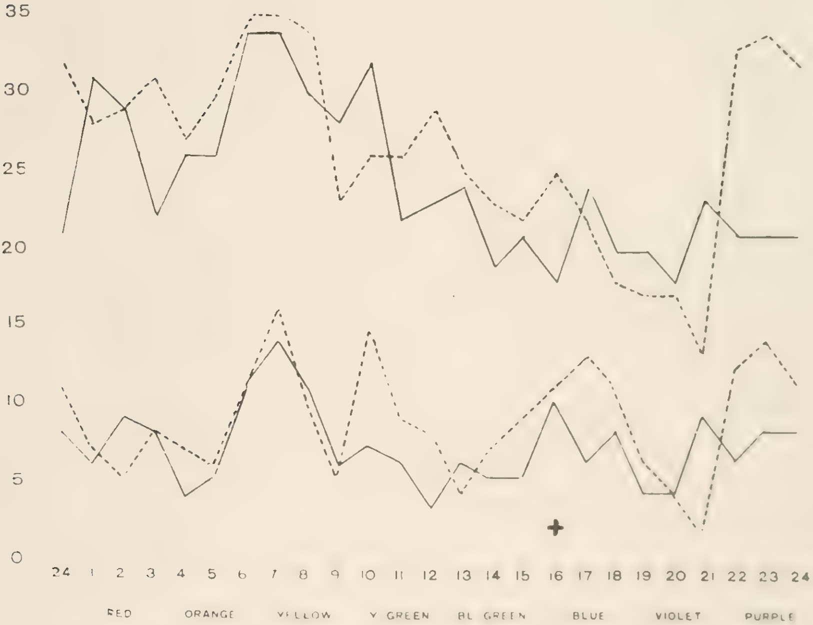

FIG. X.—YELLOW, SHADES AND COLOURS

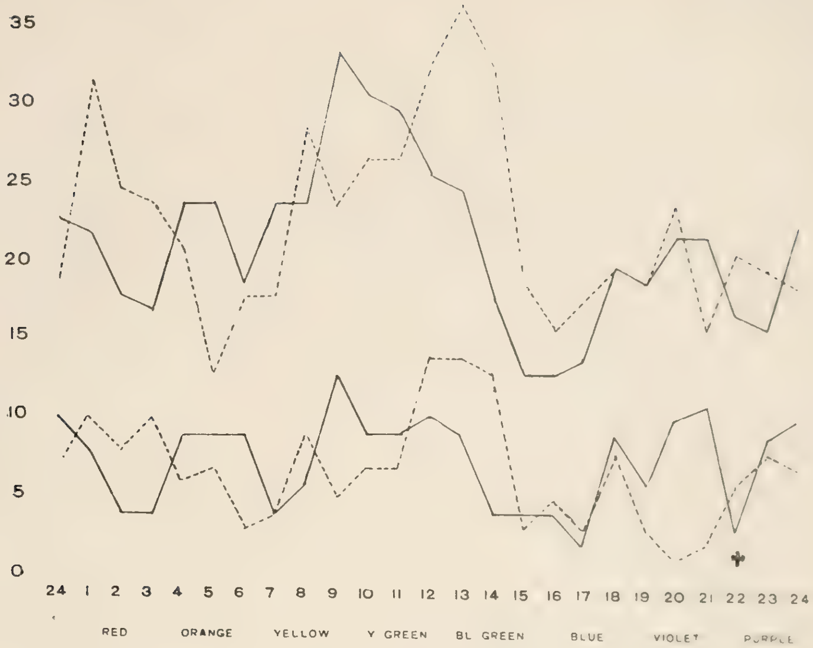

FIG. XI.—YELLOW-GREEN, TINTS AND COLOURS

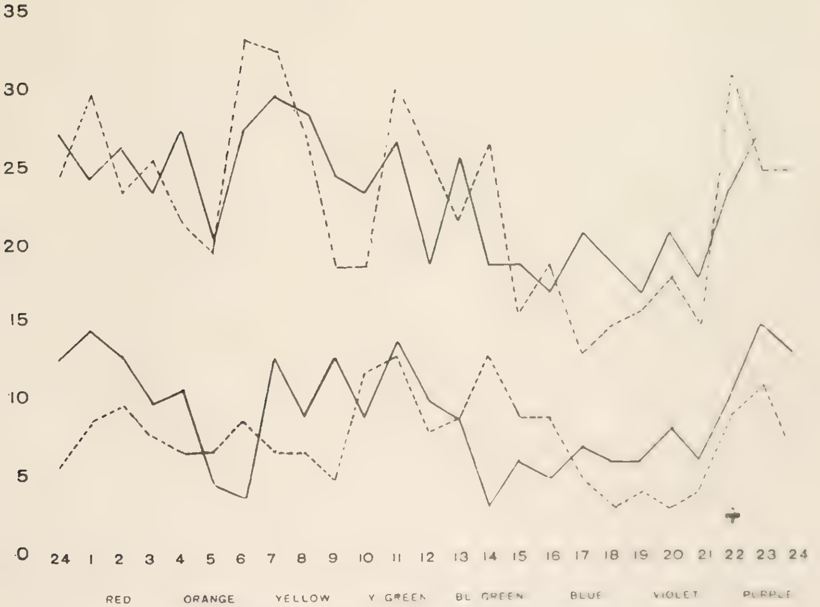

FIG. XII.—YELLOW-GREEN, SHADES AND COLOURS

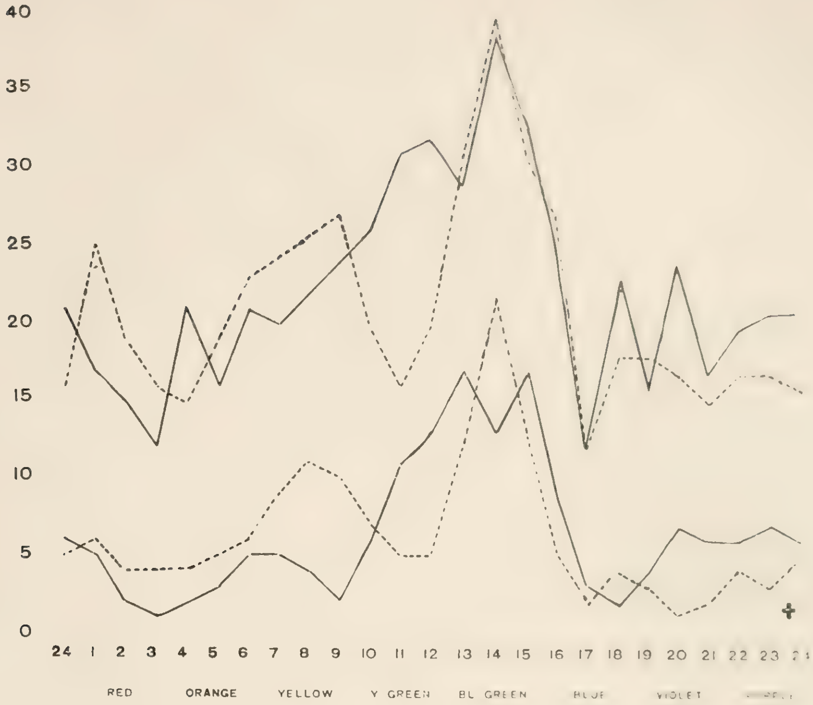

FIG. XIII.—BLUE-GREEN, TINTS AND COLOURS

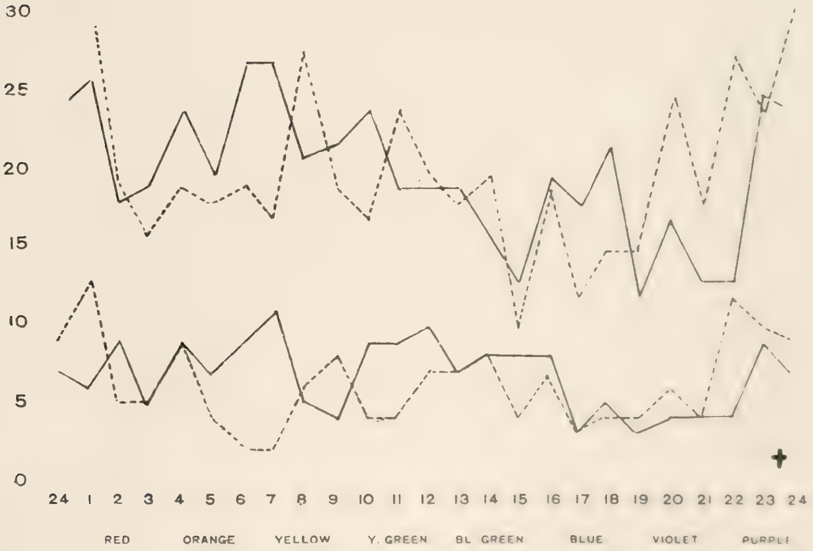

FIG. XIV.—BLUE-GREEN, SHADES AND COLOURS

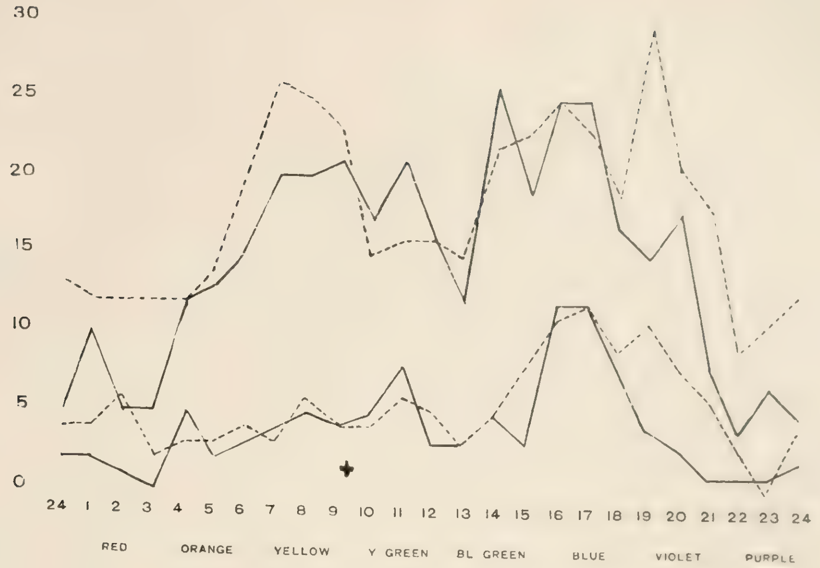

FIG. XV.—BLUE, TINTS AND COLOURS

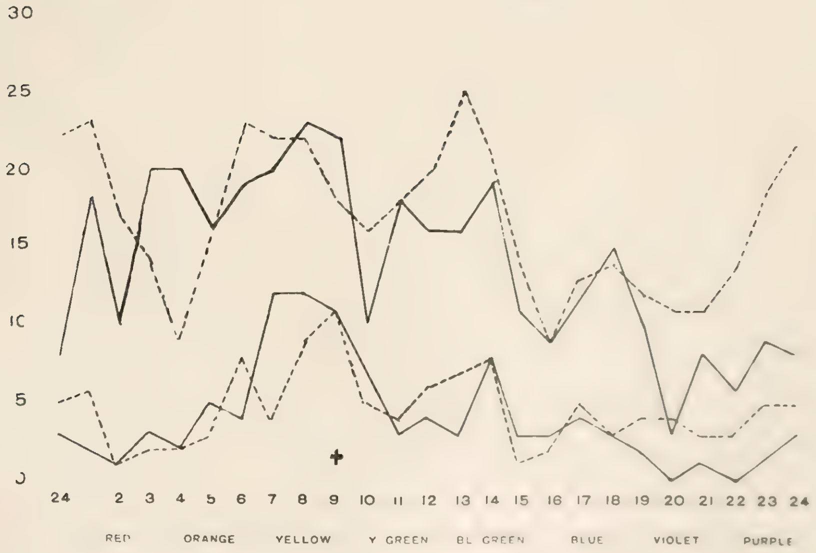

FIG. XVI.—BLUE, SHADES AND COLOURS

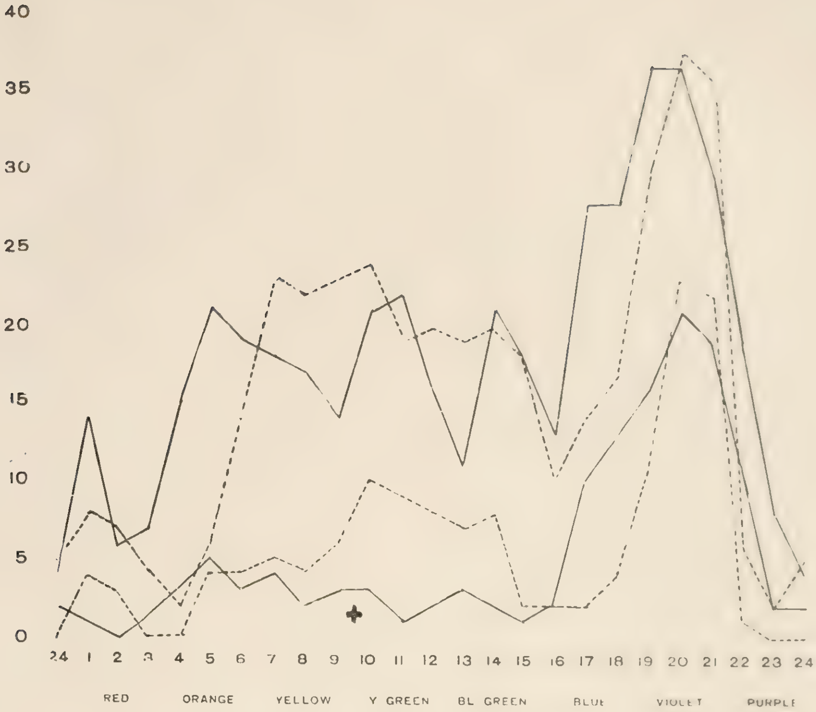

FIG. XVII.—VIOLET, TINTS AND COLOURS

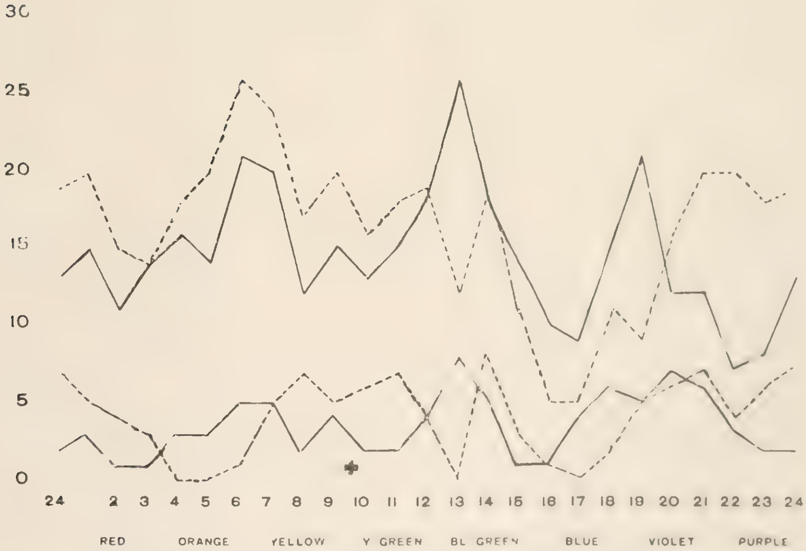

FIG. XVIII.—VIOLET, SHADES AND COLOURS

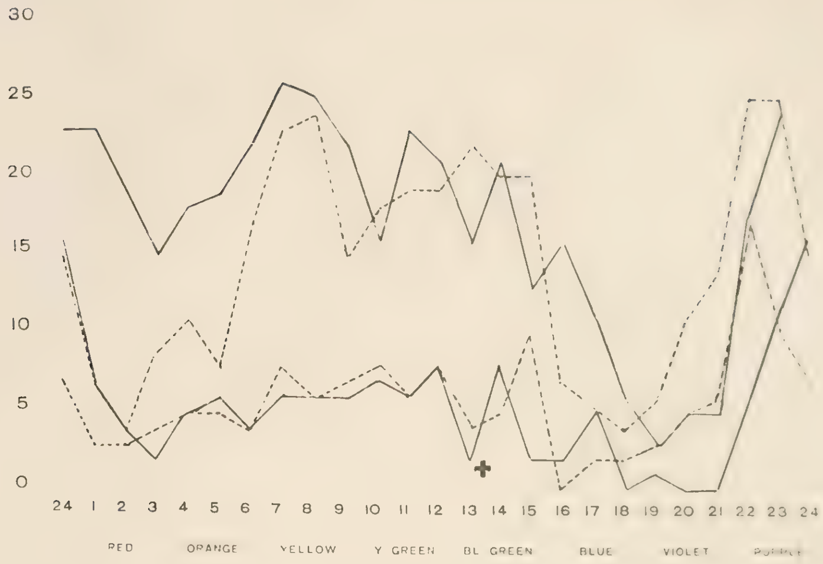

FIG. XIX.—PURPLE, TINTS AND COLOURS

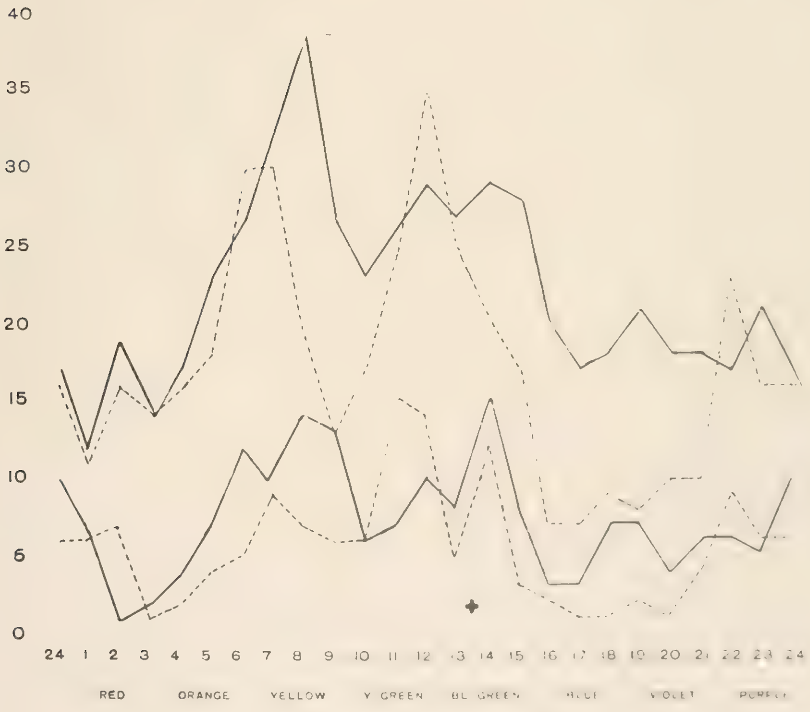

FIG. XX.—PURPLE, SHADES AND COLOURS

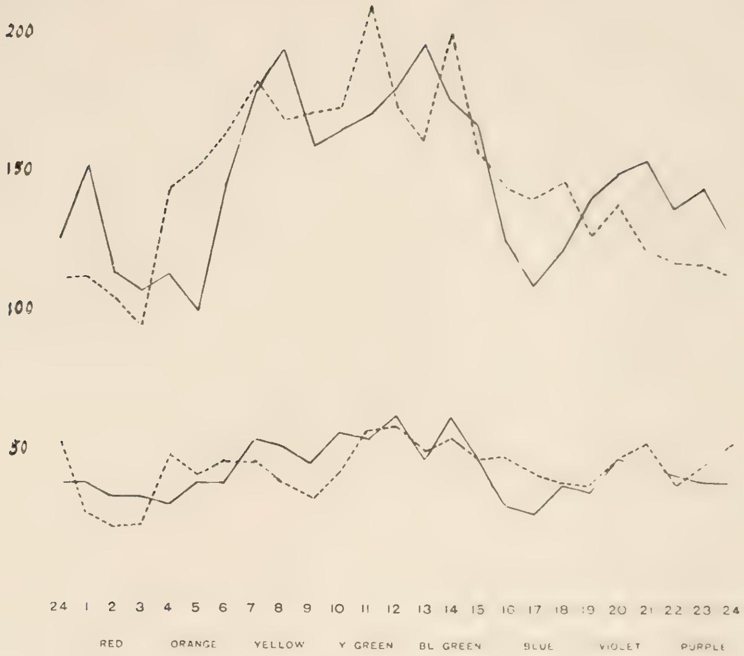

FIG. XXI.—SUMMATION CURVE, TINTS AND COLOURS

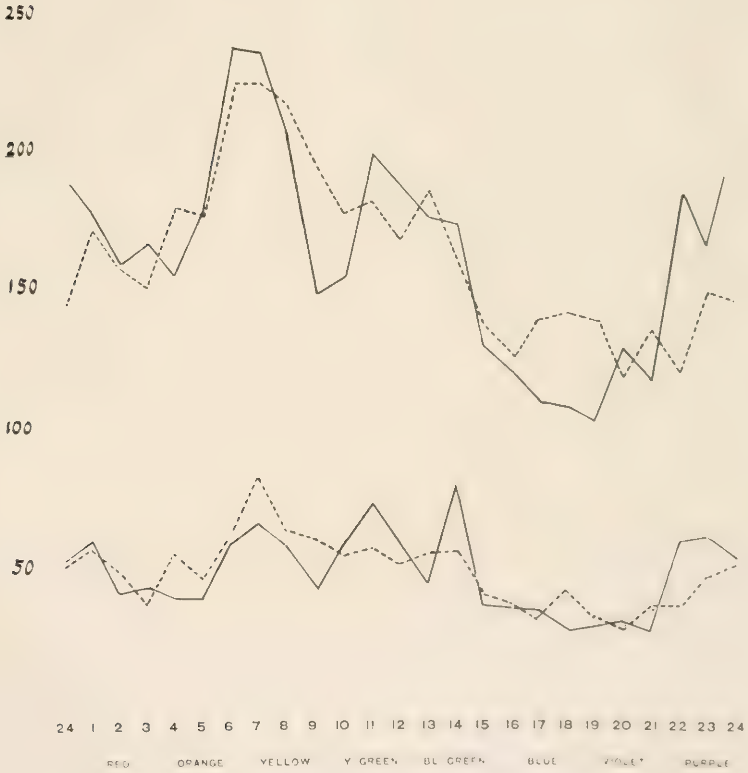

FIG. XXII.—SUMMATION CURVE, SHADES AND COLOURS

COLOUR AESTHETICS

(SECOND ARTICLE)

COMBINATIONS OF COLOURS, TINTS AND SHADES

BY

F. LOUIS BARBER, M.A.

BINARY COMBINATIONS OF TINTS AND SHADES AMONG THEMSELVES AND WITH ONE ANOTHER.

In the first article we have treated the combinations of colours in full saturation with tints and shades. We have now to examine the aesthetic characteristics embraced in the combinations of shades with shades, tints with tints, shades with tints, and tints with shades. The room, the means of experiment and method employed were the same as used in the examination of colours with tints and shades. The same may be said with regard to the time of day, instructions to the observers and all other conditions; but the number of observers was twenty-three instead of ten, and thus a larger number of judgments was obtained. There are four distinct sets of experiments. In the first two sets, concerning the combination of the shades with themselves, and the tints with themselves, the number of binary combinations judged was 24 x 23 x 23 x 2, or a total of 25.392. The other two series refer to the combinations of the tints with shades and the shades with tints. In these two latter sets of experiments the number of judgments was 24 x 24 x 23 x 2, or 26,496; and thus there is a grand total for the four series of 51,888 combinations judged.

As in the preceding paper on combinations of tints and shades with colours, the results are here represented by tables, and, in order that their significance may be more easily seen, by curves also. Tables xiii and xiv give the numbers of "pleasant" and "most pleasant" respectively for each shade with all the other shades, xv and xvi the selections of combinations of tints similarly, while xvii and xviii show the result of each shade combined with each tint. Tables xiii, xv and xvii refer to "pleasant" combinations, whilst xiv, xvi and xviii have to do with the "most pleasant." For the sake of simplicity we combine three colours in one curve. Thus Curve XLI stands for red, including colours 1, 2 and 3. Tables xix to xxvi, corresponding to these curves, thus represent the former Tables combined by threes; e.g. in xix the capability of each shade (three combined) to form pleasant combinations is shown in the eight horizontal columns. What this means may be more easily seen in Figs. XLI to LXIV, where each curve is a diagrammatic representation of the average of the three combined qualities, e.g. in red.

As in the previous paper, where a curve had been drawn for each individual colour, each tint or shade is now represented by a curve, giving 96 single curves for the pleasant, and 96 for the most pleasant. All of these cannot be reproduced in this article. But as an example a number of these curves are given in Figs. XXIII to XXX. In every case the upper curve represents the "pleasant," and the lower one the "most pleasant." The abscissæ show the colour-qualities in spectral order, while the ordinates indicate the frequency with which the tints have been chosen with tints, the shades with the shades, the shades with the tints, or vice versa. The cross (x) indicates the position of the complementary. The scale of the abscissa is twice that of the ordinate. In addition, four figures have been drawn (Figs. LXV to LXVIII) indicating for all the 24 colours the total frequency of their selection in these experiments, which may stand as a measurement of their ability to produce agreeable combinations.

It was said in the previous paper, in reference to combinations of colours with the tints and shades, that the maximum of pleasantness for the colours with the tints and that for the colours with the shades should not be expected always to occur in the same part of the spectrum.* The results of the experiments with shades and tints indicate that there is a difference in the position of the maximum of pleasantness, corresponding, more or less, to the change of intensity, through the series of tints, colours and shades, and the regularity with which this change takes place supplies a significant verification of Purkinje's phenomenon.

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* See University of Toronto Studies, Psych. Series, Vol. II, No. 3, p. 14 [178].

TABLE XIII.

SHADES WITH SHADES.

PLEASANT COMBINATIONS.

No. of Shades.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Shades
1		12	10	8	9	13	13	13	14	19	25	25	20	15	10	9	9	8	10	4	6	6	6	10	274
2	12		5	5	7	12	15	20	25	28	27	31	26	15	15	10	11	7	10	6	5	5	4	8	309
3	10	5		6	9	7	8	10	13	19	23	28	23	10	12	5	8	7	6	4	5	2	3	4	227
4	8	5	6		14	10	8	9	12	20	22	15	19	8	6	8	9	6	5	3	2	3	5	5	208
5	9	7	9	14		13	8	10	8	19	22	18	17	14	7	4	7	7	8	6	3	3	4	6	223
6	13	12	7	10	13		7	10	15	20	19	15	14	10	9	7	9	8	7	8	7	6	6	6	238
7	13	15	8	8	8	7		12	9	11	17	16	15	16	9	8	11	9	4	5	3	7	10	8	229
8	13	20	10	9	10	10	12		12	20	16	19	19	16	9	13	9	13	5	9	9	9	13	13	288
9	14	25	13	12	8	15	9	12		17	27	24	23	20	13	17	16	20	9	13	16	12	16	14	365
10	19	28	19	20	19	20	11	20	17		18	23	19	15	13	16	15	14	8	11	12	14	19	14	384
11	25	27	23	22	22	19	17	16	27	18		18	20	16	18	16	20	16	15	15	13	14	20	25	442
12	25	31	28	15	18	15	16	19	24	23	18		14	14	13	12	20	17	11	9	8	13	18	18	399
13	20	26	23	19	17	14	15	19	23	19	20	14		11	13	12	14	14	12	10	9	15	18	18	375
14	15	15	10	8	14	10	16	16	20	15	16	14	11		16	14	15	14	10	7	4	7	13	15	295
15	10	15	12	6	7	9	9	9	13	13	18	13	13	16		10	9	10	5	2	4	5	8	10	226
16	9	10	5	8	4	7	8	13	17	16	16	12	12	14	10		5	7	4	0	3	3	8	6	197
17	9	11	8	9	7	9	11	9	16	15	20	20	14	15	9	5		5	4	1	1	2	7	9	216
18	8	7	7	6	7	8	9	13	20	14	16	17	14	14	10	7	5		9	2	4	4	5	9	215
19	10	10	6	5	8	7	4	5	9	8	15	11	12	10	5	4	4	9		5	3	2	4	6	162
20	4	6	4	3	6	8	5	9	13	11	15	9	10	7	2	0	1	2	5		7	4	2	6	139
21	6	5	5	2	3	7	3	9	16	12	13	8	9	4	4	3	1	4	3	7		8	3	1	136
22	6	5	2	3	3	6	7	9	12	14	14	13	15	7	5	3	2	4	2	4	8		5	5	154
23	6	4	3	5	4	6	10	13	16	19	20	18	18	13	8	8	7	5	4	2	3	5		9	206
24	10	8	4	5	6	6	8	13	14	14	25	18	18	15	10	6	9	9	6	6	1	5	9		225
																								Total. . . .	6132

TABLE XIV.

SHADES WITH SHADES.

MOST PLEASANT COMBINATIONS.

No. of Shades.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Shades
1		2	1	3	2	2	3	2	2	7	8	11	11	5	4	0	2	3	1	1	0	3	3	4	80
2	2		1	1	0	1	3	6	7	10	12	10	12	4	3	4	5	5	3	3	2	1	1	2	98
3	1	1		3	1	2	2	2	2	5	5	5	8	2	2	0	1	1	1	0	0	1	0	1	46
4	3	1	3		8	1	2	1	2	4	7	6	7	0	0	1	1	1	1	0	0	0	0	0	49
5	2	0	1	8		4	2	1	3	5	8	8	7	3	0	0	0	2	1	2	0	0	1	3	61
6	2	1	2	1	4		1	1	3	9	8	8	6	2	1	2	0	3	2	3	1	0	1	3	64
7	3	3	2	2	2	1		3	1	1	4	3	6	0	1	1	4	3	1	0	2	1	4	2	50
8	2	6	2	1	1	1	3		2	2	2	5	6	3	1	1	2	4	2	3	1	2	4	6	62
9	2	7	2	2	3	3	1	2		4	7	4	4	5	1	4	5	7	4	5	3	3	3	2	83
10	7	10	5	4	5	9	1	2	4		5	4	3	5	3	5	4	3	4	4	2	4	2	5	100
11	8	12	5	7	8	8	4	2	7	5		7	2	3	3	4	8	3	5	5	4	3	7	6	126
12	11	10	5	6	8	8	3	5	4	4	7		3	3	2	1	2	3	3	3	3	8	9	9	120
13	11	12	8	7	7	6	6	6	4	3	2	3		3	2	2	1	1	1	4	2	3	1	6	101
14	5	4	2	0	3	2	0	3	5	5	3	3	3		1	3	5	7	2	3	2	3	3	6	73
15	4	3	2	0	0	1	1	1	1	3	3	2	2	1		1	2	1	1	0	2	1	2	5	39
16	0	4	0	1	0	2	1	1	4	5	4	1	2	3	1		1	0	1	0	2	1	1	0	35
17	2	5	1	1	0	0	4	2	5	4	8	2	1	5	2	1		2	0	0	1	0	0	0	46
18	3	5	1	1	2	3	3	4	7	3	3	3	1	7	1	0	2		0	0	1	1	1	1	53
19	1	3	1	1	1	2	1	2	4	4	5	3	1	2	1	1	0	0		2	1	1	1	4	42
20	1	3	0	0	2	3	0	3	5	4	5	3	4	3	0	0	0	0	2		4	0	0	2	44
21	0	2	0	0	0	1	2	1	3	2	4	3	2	2	2	2	1	1	1	4		1	1	1	36
22	3	1	1	0	0	0	1	2	3	4	3	8	3	3	1	1	0	1	1	0	1		2	1	40
23	3	1	0	0	1	1	4	4	3	2	7	9	1	3	2	1	0	1	1	0	1	2		4	51
24	4	2	1	0	3	3	2	6	2	5	6	9	6	6	5	0	0	1	4	2	1	1	4		73
																								Total....	1572

TABLE XV.

TINTS WITH TINTS.

PLEASANT COMBINATIONS.

No. of Tints.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints.
1		6	3	6	13	12	16	14	22	18	20	24	18	17	11	11	8	5	5	4	3	1	1	3	241
2	6		9	10	16	13	14	13	16	15	17	25	20	16	13	11	8	7	7	5	4	1	2	1	249
3	3	9		9	19	13	14	12	15	17	15	24	21	16	11	9	8	6	5	3	4	2	2	2	239
4	6	10	9		9	9	9	16	13	16	17	20	21	17	16	14	6	10	8	8	6	7	5	5	257
5	13	16	19	9		10	14	10	11	14	18	17	23	16	16	12	10	10	11	13	12	9	7	6	296
6	12	13	13	9	10		11	11	11	17	19	18	20	15	15	12	8	8	14	16	13	10	10	11	296
7	16	14	14	9	14	11		9	11	14	18	17	16	17	16	12	12	11	14	12	10	14	9	11	301
8	14	13	12	16	10	11	9		12	11	12	18	19	17	18	17	18	15	17	14	16	13	12	9	323
9	22	16	15	13	11	11	11	12		11	18	21	17	13	18	12	20	18	14	14	17	16	16	13	349
10	18	15	17	16	14	17	14	11	11		11	19	14	12	15	10	18	13	15	14	18	16	13	15	336
11	20	17	15	17	18	19	18	12	18	11		15	15	15	9	7	13	13	13	14	18	15	14	19	345
12	24	25	24	20	17	18	17	18	21	19	15		10	17	15	13	17	15	16	13	19	11	16	14	394
13	18	20	21	21	23	20	16	19	17	14	15	10		18	13	13	14	14	13	14	19	12	18	18	380
14	17	16	16	17	16	15	17	17	13	12	15	17	18		13	13	14	17	13	17	14	13	21	17	358
15	11	13	11	16	16	15	16	18	18	15	9	15	13	13		14	13	14	10	11	12	14	17	11	315
16	11	11	9	14	12	12	12	17	12	10	7	13	13	13	14		10	10	10	9	7	6	12	8	252
17	8	8	8	6	10	8	12	18	20	18	13	17	14	14	13	10		7	3	3	5	7	11	8	241
18	5	7	6	10	10	8	11	15	18	13	13	15	14	17	14	10	7		5	6	5	6	7	7	229
19	5	7	5	8	11	14	14	17	14	15	13	16	13	13	10	10	3	5		5	5	6	10	9	228
20	4	5	3	8	13	16	12	14	14	14	14	13	14	17	11	9	3	6	5		7	4	7	7	220
21	3	4	4	6	12	13	10	16	17	18	18	19	19	14	12	7	5	5	5	7		6	5	4	229
22	1	1	2	7	9	10	14	13	16	16	15	11	12	13	14	6	7	6	6	4	6		3	1	193
23	1	2	2	5	7	10	9	12	16	13	14	16	18	21	17	12	11	7	10	7	5	3		3	221
24	3	1	2	5	6	11	11	9	13	15	19	14	18	17	11	8	8	7	9	7	4	1	3		202
																								Total....	6694

TABLE XVI.

TINTS WITH TINTS.

MOST PLEASANT COMBINATIONS.

No. of Tints.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints.
1		0	0	2	1	0	3	1	6	2	6	10	6	8	1	2	2	2	0	0	1	0	0	0	53
2	0		2	3	1	1	2	3	2	2	1	7	2	6	2	2	0	0	0	1	0	0	0	0	37
3	0	2		2	3	3	2	1	1	2	3	4	4	5	3	2	2	1	0	0	0	0	0	0	40
4	2	3	2		3	2	2	0	2	1	6	7	4	8	3	1	2	4	0	4	1	2	0	0	59
5	1	1	3	3		1	4	1	2	3	6	3	10	5	4	4	3	3	3	4	2	4	2	3	75
6	0	1	3	2	1		6	2	0	3	3	2	5	4	2	8	3	3	4	3	3	2	0	1	61
7	3	2	2	2	4	6		4	2	1	4	2	7	3	2	3	2	1	2	1	4	1	1	3	62
8	1	3	1	0	1	2	4		3	1	3	2	3	2	4	4	5	4	3	0	4	2	3	1	56
9	6	2	1	2	2	0	2	3		1	3	2	5	8	2	1	4	3	2	4	6	3	3	1	66
10	2	2	2	1	3	3	1	1	1		4	4	2	2	2	1	4	1	3	3	1	4	1	4	52
11	6	1	3	6	6	3	4	3	3	4		4	3	4	0	0	2	4	2	4	8	2	2	5	79
12	10	7	4	7	3	2	2	2	2	4	4		3	4	5	3	3	2	3	3	4	3	8	3	91
13	6	2	4	4	10	5	7	3	5	2	3	3		10	4	0	1	4	4	3	4	3	5	7	99
14	8	6	5	8	5	4	3	2	8	2	4	4	10		6	4	5	9	6	5	7	4	13	9	137
15	1	2	3	3	4	2	2	4	2	2	0	5	4	6		2	6	5	4	4	2	7	8	7	85
16	2	2	2	1	4	8	3	4	1	1	0	3	0	4	2		3	1	3	3	1	4	4	3	59
17	2	0	2	2	3	3	2	5	4	4	2	3	1	5	6	3		1	0	1	0	3	3	1	56
18	2	0	1	4	3	3	1	4	3	1	4	2	4	9	5	1	1		2	2	0	3	1	1	57
19	0	0	0	0	3	4	2	3	2	3	2	3	4	6	4	3	0	2		0	2	2	0	1	46
20	0	1	0	4	4	3	1	0	4	3	4	3	3	5	4	3	1	2	0		4	1	3	2	55
21	1	0	0	1	2	3	4	4	6	1	8	4	4	7	2	1	0	0	2	4		3	1	4	62
22	0	0	0	2	4	2	1	2	3	4	2	3	3	4	7	4	3	3	2	1	3		1	1	55
23	0	0	0	0	2	0	1	3	3	1	2	8	5	13	8	4	3	1	0	3	1	1		3	62
24	0	0	0	0	3	1	3	1	1	4	5	3	7	9	7	3	1	1	1	2	4	1	3		60
																								Total....	1564

TABLE XVII.

SHADES WITH TINTS.

PLEASANT COMBINATIONS.

No. of Shades.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints.
1	15	8	13	15	18	18	16	12	17	17	21	18	22	19	7	6	5	5	5	2	5	6	8	9	287
2	10	10	9	12	18	15	16	14	15	18	20	19	23	21	11	9	7	4	4	3	3	4	3	6	274
3	9	8	9	6	9	10	12	11	15	15	15	18	16	16	8	7	5	4	5	5	5	3	3	5	219
4	6	6	10	10	12	16	11	9	8	14	15	18	15	15	9	8	8	6	7	6	6	6	7	10	238
5	10	10	14	10	15	19	14	16	17	15	19	25	18	17	9	8	6	10	7	4	6	6	8	8	291
6	12	10	11	9	16	21	18	15	11	10	17	21	19	11	8	11	7	12	8	4	10	10	10	12	293
7	12	14	18	15	15	18	18	18	14	11	19	23	25	24	11	15	16	14	13	8	9	11	12	14	367
8	13	13	14	13	15	16	17	19	19	13	18	19	21	16	13	13	13	12	12	10	10	11	14	14	348
9	15	19	18	16	14	15	14	15	18	13	16	18	17	16	16	13	12	14	12	15	12	14	16	14	362
10	22	16	17	18	25	22	18	21	24	22	21	18	17	8	7	13	15	16	15	17	13	16	15	15	411
11	21	22	20	21	20	23	18	21	22	25	30	29	30	20	14	13	18	18	19	17	19	22	20	20	502
12	22	23	19	21	25	25	22	24	25	28	29	31	29	29	24	24	19	19	19	20	21	19	21	18	556
13	17	16	16	19	24	23	22	19	22	28	27	26	29	27	19	26	16	18	17	17	17	19	19	19	502
14	9	10	9	11	15	19	16	18	20	19	23	20	26	25	19	20	13	11	14	13	16	14	15	18	393
15	6	5	5	6	10	12	13	12	12	9	17	20	20	16	21	20	13	9	9	7	9	8	7	11	277
16	7	7	10	11	14	16	15	12	23	13	18	18	18	18	16	15	17	15	18	7	3	4	7	8	310
17	8	6	7	9	10	13	11	11	14	21	19	20	17	17	17	17	20	18	12	6	4	6	6	4	293
18	8	6	8	9	10	14	13	12	13	20	20	20	15	12	15	15	18	20	16	11	6	8	10	12	311
19	10	6	9	8	10	14	9	10	13	16	18	19	15	13	13	14	16	18	21	15	9	7	9	8	300
20	7	5	9	9	11	14	10	12	14	14	14	14	14	10	7	10	7	9	11	12	11	13	11	9	257
21	7	5	5	8	8	9	5	11	12	10	14	13	14	10	7	9	5	6	8	11	10	9	8	7	211
22	6	5	3	7	10	12	13	12	13	12	18	20	17	13	6	6	2	4	5	8	9	11	5	6	223
23	12	11	7	8	12	18	16	14	14	17	18	19	22	17	10	6	5	5	6	3	5	2	7	9	263
24	13	9	6	8	17	18	16	16	15	20	21	20	24	18	9	6	5	4	5	3	7	5	6	10	281
Total	277	250	266	279	353	400	353	354	390	400	467	486	483	408	296	304	268	271	268	224	225	234	247	266	7769

TABLE XVIII.

SHADES WITH TINTS.

MOST PLEASANT COMBINATIONS.

No. of Shades.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints.
1	4	4	4	8	9	4	3	4	4	5	5	6	6	7	1	1	1	1	1	1	2	2	2	1	86
2	2	2	1	1	4	2	1	2	4	6	6	6	3	8	2	3	0	0	1	0	0	1	2	1	58
3	1	3	2	2	1	0	1	3	2	2	8	4	2	5	2	1	0	0	0	0	1	2	3	2	47
4	1	2	0	3	1	2	1	4	3	3	5	5	2	2	2	2	0	0	0	1	1	1	1	0	42
5	1	2	3	4	6	5	4	7	4	5	7	6	3	6	0	2	1	0	0	0	0	1	3	1	71
6	4	3	4	3	6	6	2	3	3	7	5	8	3	3	0	1	1	2	1	0	1	1	1	1	69
7	2	4	7	0	4	3	8	3	2	2	4	5	2	2	2	0	2	3	1	2	1	4	4	5	72
8	3	6	4	1	0	1	3	5	5	2	7	4	3	1	4	4	2	3	1	2	1	2	6	4	74
9	4	8	2	3	3	4	1	3	6	5	1	4	5	4	6	6	2	1	1	4	9	6	7	3	98
10	5	7	5	12	6	5	6	9	6	7	7	4	3	1	1	1	1	4	5	6	7	6	8	9	131
11	7	9	6	8	4	8	6	4	8	9	12	19	9	5	5	3	7	10	4	6	6	10	9	10	184
12	7	11	7	8	10	6	8	6	7	6	10	11	13	9	7	8	7	4	8	8	9	4	12	8	194
13	6	5	4	2	4	3	2	3	4	4	10	8	9	9	4	13	4	4	4	7	4	5	6	9	133
14	1	3	2	1	1	3	3	3	1	3	4	6	13	8	6	6	4	2	1	0	5	2	4	6	88
15	1	2	1	1	2	2	3	2	4	3	2	7	7	6	4	6	2	2	4	2	1	1	2	2	69
16	3	2	2	2	4	2	3	1	0	2	2	5	3	3	6	5	3	2	5	1	0	1	1	2	60
17	2	3	4	3	4	4	2	0	2	3	6	5	6	5	3	3	4	5	5	2	3	2	2	2	80
18	0	3	0	1	3	3	2	2	1	1	5	4	3	2	1	4	3	6	5	2	1	1	2	1	56
19	1	3	2	0	2	0	0	2	3	3	5	3	5	1	2	5	2	3	6	6	2	2	1	1	60
20	1	2	3	0	2	1	0	2	2	2	3	4	4	2	1	4	1	3	3	4	5	4	2	2	57
21	2	3	1	0	0	1	0	2	1	3	7	2	7	2	1	1	0	1	1	0	3	3	4	1	46
22	2	0	0	2	2	1	0	2	2	5	5	5	9	2	1	2	1	1	1	2	3	3	1	1	53
23	3	2	4	1	3	5	2	2	1	5	6	7	8	7	3	1	2	0	1	1	2	1	0	1	68
24	5	4	3	4	5	1	2	2	1	4	5	5	4	5	1	0	1	0	1	1	1	2	1	0	58
Total	68	93	71	70	86	72	63	76	76	97	137	143	132	105	65	82	51	57	60	58	68	67	84	73	1954

TABLE XIX.

SHADES WITH SHADES.

PLEASANT.

Shades.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Shades.
Red	22	17	15	19	25	32	36	43	52	66	75	84	69	40	37	24	28	22	26	14	16	13	13	22	
Orange	30	24	22	24	27	23	23	29	35	59	63	48	50	32	22	19	25	21	20	17	12	12	15	17	
Yellow	40	60	31	29	26	32	21	24	21	48	60	59	57	52	31	38	36	42	18	27	28	28	39	35	
Yel.-Green ..	69	86	70	57	59	54	44	55	68	41	36	41	53	45	44	44	55	47	34	35	33	41	57	57	
Blue-Green .	45	56	45	33	38	33	40	44	56	47	54	41	24	27	29	36	38	38	27	19	17	27	39	43	
Blue	26	28	20	23	18	24	28	35	53	45	52	49	40	43	29	12	10	12	17	3	8	9	20	24	
Violet	20	21	15	10	17	22	12	23	38	31	43	28	31	21	11	7	6	15	8	12	10	14	9	13	
Purple	22	17	9	13	13	18	25	35	42	47	59	49	51	35	23	17	18	18	12	12	12	10	14	14	

TABLE XX.

SHADES WITH SHADES.

MOST PLEASANT.

Shades.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Shades.
Red	3	3	2	7	3	5	8	10	11	22	25	26	31	11	9	4	8	9	5	4	2	5	4	7	
Orange	7	2	6	9	12	5	5	3	8	18	23	22	20	5	1	3	1	6	4	5	1	0	2	6	
Yellow	7	16	6	5	6	5	4	5	3	7	13	12	16	8	3	6	11	14	7	8	6	6	11	10	
Yel.-Green ..	26	32	15	17	21	25	8	9	15	9	12	11	8	11	8	10	14	9	12	12	9	15	18	20	
Blue-Green .	20	19	12	7	10	9	7	10	10	11	8	8	5	4	3	6	8	9	4	7	6	7	6	17	
Blue	5	14	2	3	2	5	8	7	16	12	15	6	4	15	4	1	3	2	1	0	4	2	2	1	
Violet	2	8	1	1	3	6	3	6	12	10	14	9	7	7	3	3	1	1	3	6	5	2	2	7	
Purple	10	4	2	0	4	4	7	12	8	11	16	26	10	12	8	2	0	3	6	2	3	3	6	5	

TABLE XXI.

TINTS WITH TINTS.

PLEASANT.

Tints.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints
Red	9	15	12	25	48	38	44	39	53	50	52	73	59	49	35	31	24	18	17	12	11	4	5	6	
Orange	31	39	41	18	19	19	34	37	35	47	54	55	64	48	47	38	24	28	33	37	31	26	22	22	
Yellow	52	43	41	38	35	33	20	21	23	36	48	56	52	47	52	41	50	44	45	40	43	43	37	33	
Yel.-Green ..	62	57	56	53	49	54	49	41	50	30	26	34	39	44	39	30	48	41	44	41	55	42	43	48	
Blue-Green .	46	49	48	54	55	50	49	54	48	41	39	42	31	31	26	40	41	45	36	42	45	39	56	46	
Blue	24	26	23	30	32	28	35	50	50	41	33	45	41	44	41	20	17	17	18	18	17	19	30	23	
Violet	12	16	12	22	36	43	36	47	45	47	45	48	46	44	33	26	11	16	10	12	12	16	22	20	
Purple	5	4	6	17	22	31	34	34	45	44	48	41	48	51	42	26	26	20	25	18	15	4	6	4	

TABLE XXII.

TINTS WITH TINTS.

MOST PLEASANT.

Tints.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints
Red	0	2	2	7	5	4	7	5	9	6	10	21	12	19	6	6	4	3	0	1	1	0	0	0	
Orange	3	5	8	5	4	3	12	3	4	7	15	12	19	17	9	13	8	10	7	11	6	8	2	4	
Yellow	10	7	4	4	7	8	6	7	5	3	10	6	15	13	8	8	11	8	7	5	14	6	7	5	
Yel.-Green...	18	10	9	14	12	8	7	6	6	8	8	8	8	10	7	4	9	7	8	10	13	9	11	12	
Blue-Green .	15	10	12	15	19	11	12	9	15	6	7	12	14	16	10	6	12	18	14	12	13	14	26	23	
Blue	6	2	5	7	10	14	6	13	8	6	6	8	5	18	13	4	4	2	5	6	1	10	8	5	
Violet	1	1	0	5	9	10	7	7	12	7	14	10	11	18	10	7	1	4	2	4	6	6	4	7	
Purple	0	0	0	2	9	3	5	6	7	9	9	14	15	26	22	11	7	5	3	6	8	2	4	4	

TABLE XXIII.

SHADES CONST., TINTS VAR.

PLEASANT.

Shades.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints.
Red	34	26	31	33	45	43	44	37	47	50	56	55	61	56	26	22	17	13	14	10	13	13	14	20	
Orange	28	26	35	29	43	56	43	40	36	39	51	64	52	43	26	27	21	28	22	14	22	22	25	30	
Yellow	40	46	50	44	44	49	49	52	51	37	53	60	63	56	40	41	41	40	37	33	31	36	42	42	
Yel.-Green ..	65	61	56	60	70	70	58	66	71	75	80	78	76	57	45	50	52	53	53	54	53	57	56	53	
Blue-Green .	32	31	30	36	49	54	51	49	54	56	67	66	75	68	59	66	42	38	40	37	42	41	41	48	
Blue	23	19	25	29	34	43	39	35	50	54	57	58	50	47	48	47	55	53	46	24	13	18	23	24	
Violet	24	16	23	25	29	37	24	33	39	40	46	46	43	33	27	33	28	33	40	38	30	29	28	24	
Purple	31	25	16	23	39	48	45	42	42	49	57	59	63	48	25	18	12	13	16	14	21	18	18	25	

TABLE XXIV.

SHADES CONST., TINTS VAR.

MOST PLEASANT.

Shades.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Tints.
Red	7	9	7	11	14	6	5	9	10	13	19	16	11	20	5	5	1	1	2	1	3	5	7	4	
Orange	6	7	7	10	13	13	7	14	10	15	17	19	8	11	2	5	2	2	1	1	2	3	5	2	
Yellow	9	18	13	4	7	8	12	11	13	9	12	13	10	7	12	10	6	7	3	8	11	12	17	12	
Yel.-Green ..	19	27	18	28	20	19	20	19	21	22	29	34	25	15	13	12	15	18	17	20	22	20	29	27	
Blue-Green .	8	10	7	4	7	8	8	8	9	10	16	21	29	23	14	25	10	8	9	9	10	8	12	17	
Blue	5	8	6	6	11	9	7	3	3	6	13	14	12	10	10	12	10	13	15	5	4	4	5	5	
Violet	4	8	6	0	4	2	0	6	6	8	15	9	16	5	4	10	3	7	10	10	10	9	7	4	
Purple	10	6	7	7	10	7	4	6	4	14	16	17	21	14	5	3	4	1	3	4	6	6	2	2	

NOTE.—These two Tables were taken from the horizontal columns in Tables XVII, XVIII.

TABLE XXV.

TINTS CONST., SHADES VAR.

PLEASANT.

Tints.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Shades.
Red	36	29	26	22	34	33	44	40	52	55	63	64	49	28	16	24	21	22	25	21	17	14	30	28	
Orange	51	45	25	38	44	46	48	44	45	65	64	71	66	45	28	41	32	33	32	34	25	29	38	43	
Yellow	45	45	38	28	47	44	50	55	47	63	61	71	63	54	37	50	36	38	32	36	28	38	44	47	
Yel.-Green ..	56	57	48	47	59	48	53	50	47	61	84	88	81	62	46	49	60	60	53	42	37	50	54	61	
Blue-Green .	48	55	40	39	44	38	60	50	49	32	64	82	75	70	57	52	51	42	41	31	31	36	49	51	
Blue	16	20	16	22	24	30	45	38	39	44	49	62	60	44	42	47	55	53	48	26	20	12	16	15	
Violet	12	10	15	19	17	22	30	32	39	45	55	60	51	43	25	28	22	33	45	34	29	22	14	15	
Purple	23	13	11	23	22	32	37	39	44	46	62	58	57	47	26	19	16	30	24	33	24	22	18	21	

TABLE XXVI.

TINTS CONST., SHADES VAR.

MOST PLEASANT.

Tints.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Shades.
Red	12	5	6	3	6	11	13	13	14	17	22	25	15	6	4	7	9	3	6	6	6	2	9	12	
Orange	21	7	3	6	15	15	7	2	10	23	20	24	9	5	5	8	11	7	2	3	1	5	9	10	
Yellow	11	7	6	8	15	8	13	13	10	21	18	21	9	7	9	4	4	5	5	4	3	4	5	5	
Yel.-Green ..	16	18	14	13	18	20	11	13	10	18	40	27	22	13	12	9	14	10	11	9	12	15	18	14	
Blue-Green .	14	13	9	6	9	6	6	8	15	5	19	29	22	27	17	12	14	6	8	7	10	12	18	10	
Blue	3	3	1	2	3	4	5	9	9	6	20	19	21	12	10	10	12	13	10	8	2	4	3	1	
Violet	4	1	1	2	0	2	4	4	14	18	16	25	15	6	7	6	11	8	14	12	4	6	4	2	
Purple	5	4	7	2	5	3	13	12	16	23	29	24	20	12	5	4	6	4	4	8	8	5	2	3	

NOTE.—These two Tables were taken from the perpendicular columns in Tables XVII, XVIII.

This may be seen at once upon a comparison of the single curves for the shades with shades with those for the tints with tints (which involves a transposition for a considerable difference of intensity). According to Purkinje's phenomenon the colour quality of the spectrum shifts with the change of intensity, i.e., with added intensity the colour quality moves toward the yellow pole of the spectrum, while with decreasing intensity the colour tone is altered in the direction of the blue. Let it be assumed that we have located the maximum of agreeableness for shade combinations. When the shades by the addition of intensity are transformed into tints, the colour quality is moved toward the warm end of the spectrum. We should, then, look for that same quality, having the maximum, at a point in the spectrum farther from the yellow pole. The consistency with which this phenomenon actually appears in our results is almost surprising.

If we inspect the 24 curves for shades (and their corresponding curves for the "most pleasant") and compare them with the similar curves for the tints, we find that the difference in the position of the maximum in the series is usually from 1 to 3 qualities, i.e. 1 to 3 twenty-fourths of the whole extension of the spectrum. (These curves, not here reproduced, are preserved in the Psychological Laboratory.)

In curves 1, 2 and 3 for the tints (that is, when tints 1, 2 and 3 are combined respectively with all the other tints) the maximum stands at 12, while in the shades it stands at 11, 10-12 and 12 respectively. It is even more marked in the next three curves, where for the tints the maximum is at 13, and in the shades is at 11, 11 and 10 (Figs. XXIII, XXIV). In curves 7, 8 and 9, which show the combining power of the yellows, since yellow is near the spectral pole, we should not look for so marked a change of position of the maximum, and as a matter of fact these curves in the tints form irregular plateaus with their highest points at 11, 13 and 12, while in the shades the more pronounced peaks have moved over to 11, 10, 11 (Figs. XXV, XXVI). Two of these curves (7, 9) also have minor projections in the red, which shift one colour in the direction opposite to that of the previous cases. But the apparently contradictory fact may be mentioned that in curve 8 this secondary peak is shifted toward the blue. What incidental circumstance may have occasioned this slight variation in a minor elevation of the spectrum is not known; but, as in the whole field of the present observation this is the one exception to the strict obedience to Purkinje's law, we feel constrained to look for the reason in some accidental circumstance or association. In the yellow-green (curves 10, 11, 12) the plateaus continue to show little change at maxima; 11 obeys the law to the extent of 1 colour, the maximum falling in the shade at 2; while here the second prominence, indicating great pleasantness, lying in the yellow, remains unaltered. The curves for the blue-green and the blue are not high, the three for the former being irregular and having depressions at violet and orange: the three for the latter finding agreeable combinations in the yellow. In the curves for blue, the secondary elevations which stand in the red section in the shades stand at purple in the tints; while the yellow maxima in these curves would indicate that the "yellow pole" lies toward the yellow-green, as the movement is in that direction. (See p. 18 *infra,* and cf. Miss Baker's reference to "orange-yellow."*)

As we pass over into the violet section of the colour circle, while in the tints the greatest agreeableness is found between 16 and 14, indicating perhaps a slight tendency toward the blue-green, the maximum in the shades falls at 11, 10 and 9. This absence of a decided change we might anticipate from the fact that violet is not of great combining power, and also because it approaches the spectral pole. But perhaps a better interpretation of these diagrams would be to take the exceptional projections in the yellow sections of the curves for violet tints, which have nothing analogous in the shades, as a record of the peculiar affinity of violet and yellow in the tints. This is shown by a decided depression in the latter. Such being the case, the remaining portion of the tint-curves, compared with those of the corresponding shades, strikingly corroborates the law. As to the purples, the representative maxima are 9, 10, 15; 14; and 11, 13 in the tints: and 10, 11, 13; 11; and 11 (Figs. XXVII, XXVIII) in the shades, which seems to strengthen the testimony of the preceding curves. A comparison of the curve showing the total number of selections for each shade (Fig. LXV) with that exhibiting the tints similarly (Fig. LXVI) upholds the verdict of the individual curves, as the maximum of the former is at 10, of the latter at 11.

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* University of Toronto Studies, Psych. Series, Vol. I, No. 4, p. 37 [213].

When we enter upon an examination of the shades combined with the tints, and the tints with the shades, in reference to this question, it is well to superpose the curves; thus in Fig. XXIX curves for red 1 are reproduced. Here the plain curve shows shade 1 combined with the tints, while the dotted line indicates the combining power of tint 1 with the shades. (See also Figs. LVII to LXIV.) Through this whole series of 24 figures we observe a remarkable consistency as to the relative position of the maxima for the shades and for the tints. The fact that the maxima in the curves representing the shades as the constants invariably fall to the right of the maxima of the curves which represent the tints as the constants (before we pass the violet-blue pole) would lead us to ask the question, whether a difference of intensity be not the influencing factor as seen in the curves for the shades with shades and the tints with tints. But in this case at first glance there seems to be a consistent movement in the opposite direction to that observed in the other series. Before, however, we can accept this as a correct statement it is necessary to inquire where the change of intensity really appears, when shades are combined with tints and vice versa. If, when the shades are constant and the tints variable, we look for the maximum of pleasantness nearer the yellow-green, i.e. to the left of the maximum in the series in which the tints are constant, we are assuming that the intensity of the combinations in the former series is less than that in the latter. But, since in the former the shades are the constants, Purkinje's law would only be operative with reference to the variables which for each exhibition of the combinations display the spectral qualities, and therefore the shifting of the colour-quality in relation to the change of intensity is observable only with reference to the variables. Hence the maximum in the curves for the shades with the tints (e.g. the curves for red) falls to the right of the maximum of the curves representing the tints with the shades: for the variables (the tints) in the former, being of greater intensity than the variables of the latter (the shades), have their corresponding colour-quality at any particular point of the colour circle nearer the violet-blue pole. Thus it is seen that the apparent contradiction is rather a consistency and contributes one of the most interesting evidences of the law. As we survey the series of curves indicating the selections of pleasant combinations of the shades with the tints, and vice versa, we observe that in curve 1, where the shade is the constant, the maximum lies one degree to the left of the maximum for the constant tint. This is also true with the curve representing the other two reds. The position of the maxima for the 6 curves in the orange and yellow assumes a similar position. As in the former experiments we found that the maxima in the curves for polar yellow-green, which fall in the green, show little inclination to alter with the change of intensity, so here the greatest pleasantness of the combinations with the shades as constants coincides with that where the tints are constant. While the general outlines of the blue-greens are in harmony with the observations in reference to the law under examination, there are some irregularities of detail which might be accounted for by the fact that in the Prang system of colours there is a certain compression of qualities between the poles through green and blue as compared with the greater distance round the colour circle the other way—from pole to pole through the orange.* In the blue, the movement with the change of intensity is clearly indicated in the outlines, even to details, until the maxima are reached, which serves to show the greenish-yellow, instead of the yellow (cf. p. 16 *supra*), to be the warm pole; and when the maxima pass the yellow-green we are not to be surprised, since the blue is near the polar colour, to see action due to contrast manifest itself in such peaks as the tall blue-green tint and yellow shade in blue 16. This preference, overshadowing the shifting of quality with change of intensity, is also seen in the two blue curves, though to a small extent (cf. p. 15 *supra*).

The last six diagrams in the series definitely give the testimony of the violet and the purple to the phenomenon under examination, and also corroborate the conclusion that the poles lie not at yellow and blue but a little to the right of each.

To sum up regarding this series of curves, it may be stated that the peaks of greatest pleasantness shift their position on the colour circle in the direction from the blue-violet towards the greenish-yellow or vice versa, as the intensity of the combination is varied (though on account of the greater distances between the poles on the side through the red, in the Prang system of colour qualities, the phenomenon is at this side more easily observed).

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* *Vide* University of Toronto Studies, Psych. Series, Vol. I, No. 4, p. 67 [243]

The series recorded previously, which have to do with the colours in relation to the tints and the shades, upon examination will be found also to verify the statement with reference to the shades and the tints with themselves.* What was said above regarding shades with tints and vice versa, with reference to the variables changing the position of the maximum with their change of intensity, also applies to this series. Since the variation of quality, intensity, or any other factor may result in a marked change in the agreeableness of combinations, which we should by no means seek to account for by Purkinje's phenomenon, we may not look for our curves to be similar throughout. In so far as any change of quality or intensity in the experiments is greater than that induced by the said phenomenon, just so far we must not be surprised to find wide differences in the pleasantness of the series. Hence the remarkable feature of all these curves is not that their points of greatest agreeableness lie in different regions of the spectrum and rise to different altitudes, but rather that notwithstanding this fact there is such a noticeable persistency in the relative position of the peaks. For example,† while the curves in Fig. XIII bear scarcely any similarity in general outline to those of Fig. XIV, because the tints find their most harmonious partners among the blue-green colours, whilst the shades in that quarter are least agreeable, yet we notice the decided tendency of the plain curve in the former (where the tints are the variables) to fall, in relation to the dotted curve, nearer the violet-blue pole, particularly in the red and yellow-green sections, and the curve (plain) in the latter, in which the shades are variables, indicates in general outline a preference for the yellow, e.g. decidedly in green and purple; and as to a comparison of the former with the latter, it will be observed that without exception the region of greatest pleasantness with the tints as variables is farther from the "warm" colours than that in the shade curves. These observations are justified by an inspection of the summation curves (Figs. XXI, XXII), where the maximum of the combined shades and colours is at the yellow pole, while the corresponding elevation in the tints stands nearer the blue section, viz. in the green. The plain curve in Fig. XXI, in common with the dotted one, has a peak at yellow, while the maximum in the one moves to the blue-green, leaving that in the other at greenish-yellow. The relation between the two lines in Fig. XXII is inversely similar—also noticeable in the green section. If it is desired to trace the phenomenon through the fourteen figures similar to XIII and XIV it will be found that what has been said holds generally: in Figs. V to X quite regularly; also in XII, XIV, XVI; and in XVII most remarkably. But in the green tint-curves (XI, XIII) there is one quality which is so decidedly partial to its own colour that it presents a striking feature at this part, while the rest of the outline indicates the usual change. As to the violet shades (XVIII), in their choice of the violet itself the position of these secondary peaks may be accounted for by the fact that the quality is already so near the pole, that the difference of intensity in the two curves is overshadowed by the preference for other contrasts. This may also be taken as a further evidence of the violet approximating the polar colour. (*Vide* pp. 15, 17, 18 *supra.*) The purple, also a difficult colour to match, offers some variation, for while in tints with colours the ends (red and purple) of the spectrum are exceptional (Fig. XIX), yet in Fig. XX it is the centre (green), which indicates such a peculiarly decided selection, in the yellow-green shades with the colours.

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* *Vide* University of Toronto Studies, Psych. Series, Vol. II, No. 3, pp. 1-20 [165-184].

† Ibid.

Further confirmation of the observation in reference to shifting of the point of maximum pleasantness due to change of intensity, is found in the curves for complementarism (XXXI to XXXIX). In the curve for shades the line passes the abscissa between 9 and 10; in that for the tints it is between 10 and 11; while at the purple section a corresponding movement is seen in the tints toward the blue. In the curve for colours with themselves there is a peculiar change in reference to the yellow, which has its point of greatest pleasantness on the violet side of the blue, whereas in the former curves (shades and tints) the maxima are at yellow-green (and red). The reason for this is not evident, though a comparison of Baker's curves for yellow with Figs. XLV and XLVI below will show that in the latter there is a minor projection in the violet-blue, and in the former there are high prominences in yellow-green and red.

As an introduction to the remarks on complementarism with which the following pages are concerned, a survey of Figs. XXXI to XXXIX will be to good purpose. These diagrams show the relative position of the maxima and the complementaries in each of the series which we have examined. The abscissa-line shows the complementaries, while the curves represent the distances at which the maxima lie from them. The abscissæ and ordinates are drawn on the same scale. The maxima lying to the left of the complementaries are drawn above the abscissa-axis, while those to the right are shown below it. Thus the greatest contrast would be exhibited by the curve falling upon the complementary line, while the highest or lowest peaks show the small contrasts. Fig. XXXI is drawn from an examination of Baker's curves for colours combined with colours, while Figs. XXXII and XXXIII are taken from the present work, tints with tints and shades with shades. In XXXIV and XXXV a similar exhibition is given in reference to the shades with the tints and tints with the shades, while XXXVI, XXXVII, XXXVIII and XXXIX deal with the possible combinations of colours with shades and with tints.

The examination of these figures in reference to complementarism leads to a discussion of some of the rules laid down provisionally by Professor Kirschmann.* Most of these propositions, in so far as our experiments are relevant to them, seem to be verified by our results; though more definite statements may be possible upon examination of the diagrams, where it may be seen that some of the rules have application only to a restricted area of the spectrum. For instance, a survey of the curves representing the relation of the complementary to the maxima indicates that his first rule, viz. "Our sense of sight seems to find pleasure in combination (of two components) with a maximum, or at least a great, contrast effect," applies particularly to the terminal parts of the spectrum (blue, violet, purple, red, orange). It is interesting to note that, while in those diagrams which represent an intensity and a saturation contrast as well as a colour contrast (T. S., S. T., C. T., T. C., C. S., S. C.*), there is a preference for less contrast of quality—the quality-contrast being replaced by contrast of intensity and of saturation, in those diagrams (S. S., T. T., C. C.) in which a contrast is confined to that of quality—except in so far as there is a difference of intensity in the same saturation, e.g. between yellow and blue (*vide infra*, p. 25)—there is a uniformity in the three curves which indicates a choice of wide colour contrast, except in the yellow and green with their adjacent colours, where there is contrast of intensity and quality but not of saturation. The blues, violets and purples make pleasant combinations with qualities but slightly removed from the complementary. In the case of the shades and the tints, each with themselves, the maxima in the orange and yellow fall to the left of the complementaries, i.e. in the greens (see Figs. XXIII, XXIV), while the maxima in the greens lie to the right, i.e. in the reds (see Figs. XXV, XXVI). This means that while the complementaries in these cases lie near the blue pole (at blue and violet-purple respectively), the maxima are in the greens and reds. Further indisputable evidence of the rule that "intensity contrast may replace that of quality" is offered by Fig. XL, showing intensity contrast in the same quality. The curves are drawn from the diagonal columns of numbers in the tables combined to give Tables xvii, xviii. The plain curve stands for the combination of the shades with tints of their own quality; the dotted line vice versa, viz. tints constant and shades variable.

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* Kirschmann, *On the Aesthetic Significance of Light and Colour Contrast* (Philos. Studien, Vol. VII, p. 391). For statement of rules see Baker, *Experiments on the Aesthetic of Light and Colour* (University of Toronto Studies, Psych. Ser. Vol. I, No. 4, p. 39 [215], foot-note.

Kirschmann's rule 7, according to which the dogmatic statement that certain colours will not combine with certain other colours is unverified, is corroborated by our experiments; for while our 2,556 different combinations are very far from exhausting the possible number, intensity saturation, colour-quality and shape being considered, yet there is scarcely a combination of two qualities which under some conditions has not been many times chosen as agreeable.

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* T_2 and S_2 in the previous article are synonymous with T and S in this one, as T_1 and S_1 were not used.

The remark in rule 4 that "combinations of different saturation degrees (practically shades and tints) of the same colour or of very similar colours are also found to be pleasant," is strikingly verified by a survey of Tables xvii, xviii, and Fig. XL, and especially in the case of the yellow-green, blue-green and blue, which find even their maximum pleasantness in their own qualities (that is, within 1-24th of the colour circle).

Rule 8 states that "colours of high saturation and of equal brightness when combined do not make combinations of marked agreeableness." If we compare the experiments performed by Baker, when colours of high saturation and of approximately equal brightness were used, with those of the other series discussed in this article, it will be found that while the average number of selections of the "pleasant" made by each observer for all the colours (with themselves) is $\frac{10742}{30} = 358.2$,* the other series are:

$$\text{S.S.} \quad \frac{6132}{23} = 266.6$$

$$\left.\begin{array}{l}\text{S. C.}\\ \text{C. S.}\end{array}\right\} \frac{3905}{10} = 390.5$$

$$\left.\begin{array}{l}\text{T. S.}\\ \text{S. T.}\end{array}\right\} \frac{7769}{23} = 337.7$$

$$\left.\begin{array}{l}\text{C. T.}\\ \text{T. C.}\end{array}\right\} \frac{3532}{10} = 353.2$$

$$\text{T.T.} \quad \frac{6694}{23} = 291.0$$

But since in the series C. C., S. S., T. T., there is one combination less (each colour with itself) than in the others, an exact comparison would give the following:

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* University of Toronto Studies, Psych. Series, Vol. I, No. 4, p. 47 [223].

$$\text{S.S.} \quad \frac{266.6}{23}=11.59$$

$$\left.\begin{matrix}\text{S. C.}\\ \text{C. S.}\end{matrix}\right\} \quad \frac{390.5}{24}=16.27$$

$$\left.\begin{matrix}\text{T. S.}\\ \text{S. T.}\end{matrix}\right\} \quad \frac{337.7}{24}=14.07$$

$$\left.\begin{matrix}\text{C. T.}\\ \text{T. C.}\end{matrix}\right\} \quad \frac{353.2}{24}=14.71$$

$$\text{T.T.} \quad \frac{291.0}{23}=12.65$$

$$\text{C.C.} \quad \frac{358.2}{23}=15.57$$

These figures lead us to the conclusion that colours of equal intensity and of high saturation do make combinations of marked agreeableness, far surpassing combinations of either less or greater intensity and of less saturation, when the components are of equal intensity (i.e. shades with shades and tints with tints), and of the others being only slightly excelled by the colours when combined with the shades.

But it must not be forgotten that the best saturation in the Prang system is far from being a full saturation, as can easily be seen by comparing the Prang system, as it was used in our trials, under ordinary illumination, with the same Prang colours illuminated with proper colour-filters. Further, the fact that the different colour-qualities in the same series (in the Prang system) differ in intensity is a matter for consideration. For instance, the yellow is much brighter than the blue. So that to say that the above figures for the colour series, in comparison with the other series, give us an exact indication as to how far "colours of high saturation and of equal brightness" do make combinations of marked agreeableness would need to be qualified by the condition of the diversity of intensity within each series, especially since a survey of the curves for this series (see Baker's article) will show that the most decided prominences fall where this intensity contrast would be the greatest, which fact is especially conspicuous in curves for red, blue, violet and purple.

This leads to a consideration of von Bezold's and Kirschmann's proposition that "it is not in the combination of complementary colours that we have the most harmonious effects;"* for our diagrams throughout the different series give positive evidence in this direction. There is, however, one case that needs consideration. A glance at the curves in the three series, colours, tints, shades, each with themselves, shows that the maxima in the curves for blue fall at or very near the complementary (also shown in curves XXXI, XXXII, XXXIII). But while at this point we find the greatest intensity difference within each series, it seems reasonable to suppose that had not the light contrast helped to fix the maxima at this point they would have fallen at a short distance on either side of the complementary. This surmise is verified by a survey of the curves showing the relation of the complementary and the maxima when there is a difference of intensity between the series (Figs. XXXIV to XXXIX). Consulting these curves, let us examine the yellow quality in diminished intensity (in a shade series) combined with a blue of higher intensity (either a saturated or a tint series), thus partially eliminating the intensity contrast between the yellow and the blue in the series of equal saturation. If what has been said above be correct we should expect the maxima to fall some distance from the complementary; which is seen to be the case in curves XXXIV, XXXVII, XXXVIII (cf. also Figs. LIX, LXII). The same will be observed also in those series in which the intensity of the yellow is increased or that of the blue diminished, i.e. in those where the blue in the shade is compared with the yellow of the saturated colour or its tint. The intensity contrast in this case is increased beyond that found between the two colours in the same series (see Figs. XXXV, XXXVI, XXXIX). In this case the increase of intensity in the yellow and the decrease of intensity in the blue, through the intensity contrast, decreases the saturation in both cases, the one (tint) towards the bright grey, and the other (shade) towards the corresponding dark grey.†

There is also to be considered the change of quality according to Purkinje's phenomenon, induced by the intensity difference, though in this case it will be so small that its effect may not be noticed. It has been suggested that the contrast of quality might be observed to intensify the saturation of the components, or at least to nullify the contrary effect of the intensity increase. But the slightly exaggerated condition of contrast exhibited in the following experiment where the saturated colours are used will serve to show conclusively that the effect of decreasing saturation by intensity increase far exceeds the opposite tendency of quality contrast with these particular colours. On a saturated blue field, 6 inches by 3 inches, place two isosceles triangles of a saturated yellow, their bases coinciding with one end of the blue field, and their apices falling at the other extremity. Between them a triangle is formed of the blue. The phenomenon is well observed if one stand at a distance of 10 feet from the figure. From such an experiment it will be seen that the narrow portion of the blue has become darker and less blue, and that the corresponding portions of the triangles of the complementary colour are brighter and less yellow.

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* University of Toronto Studies, Psych. Series, I. 215. See also Dobbie, *Experiments with School Children on Colour Combinations.* (Ibid. I. 251.)

† Cf. Kirschmann's discussions of the Colour-cone in Am. Jour. of Psych., VII. 394, and in Archiv für die gesamte Psychologie, VI, 407.

Figs. XLI to LVI are curves (tints with tints, and shades with shades) drawn from the average of the three horizontal columns whose totals are seen in Tables xix to xxvi. Thus it is seen that Fig. XLI represents the power of agreeable combination of the colour red (no. 2) in company with 1 and 3. Here the unmistakable pleasantness in the combination of red and green in the tints and in the shades corresponds to the result obtained in the former experiments with the tints and the colours, and shows virtually no change from the curves representing each of the three reds. Orange also combines most pleasantly with the greens, but the peaks are not so marked as in the curves for red, while there is also a secondary prominence indicating some agreeableness in its combination with the red. The yellow is more indifferent in its pleasantness of combination, for, as in the case of the colours with the tints and the shades, the curves extend irregularly over the whole field, with a preference for yellow-green and red. The curves have no high peaks. Nevertheless they cover a larger surface, that is, although the preference for certain colours is not so pronounced the general agreeableness is greater. At a considerable elevation the indication of the power of agreeable combination with a wide range of other colour qualities is in direct contradiction to the above mentioned statement of aversion to yellow and a further confirmation of Baker's results in reference to the same question.*

More general and more conclusive results may be found in an examination of the Summation Tables. In colours with themselves yellow stands without a peer (Baker's Combination Curve XXXVII). Külpe, in reporting upon Baker's results, uses the word "yellow-green."† Since we are in this article dealing with a greater variety of combinations, in which the maxima move into the green, we may mention that Baker's maximal points for the pleasant fall in the orange-yellow and green-yellow, at 8 and 10 (see Tables ii, iii, the 8 being only 1-559th higher than the 10), while the most pleasant maximum is at yellow 9. When colours are combined with tints it is only inferior to green (yellow-green numbers 11 and 13, Tables i, ii; see also Table ix); and in colours and shades yellow predominates (Table xi and Tables iii, iv indicate the yellow toward the orange, 6, 7). Though in the four series in which shades and tints are judged the greens stand highest (at 11, 12; see Tables xiii to xviii), yellow is the next highly favoured (see also Tables xxvii to xxxii *infra*). These conclusions are less liable to the criticism of limitation, since they rest upon 2,556 different combinations, quality, saturation and intensity being varied. Upon these combinations, reckoning the "most pleasant" judgments to duplicate the number, and remembering that the colour series was repeated, there were 216,092 judgments made, of which 39,995 were recorded as choices (pleasant or most pleasant).

It is important to compare these results with those of Miss Chown's investigation with greys and colours, where yellow and green are decidedly in the minimum. With the question as to why this difference should be found Miss Chown has dealt carefully. She says, "Perhaps yellow and green are preferable in combination with other colours because they are most indifferent, emotionally, thus furnishing in such combination a considerable contrast with regard to hedonic tone. This same quality of comparative indifference makes them least apt when combined with indifferent grey because there is not enough variety in the hedonic tone."* If, however, this be the explanation it may be difficult to account for the fact that in the results with colours, shades and tints, these qualities "emotionally indifferent" form highly pleasant combinations among themselves (see Baker's curves for green and yellow; colours with tints and shades, Tables ix to xii; and the summation curves below). But again, the intensity contrast may account for this.

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* Op. cit., pp. 53 and 72.

† *Bericht über den II. Kongress für experimentelle Psychologie*, p. 28.

Turning to the description of the figures in hand, we find that curves for yellow-green and blue-green are similar to those for yellow, except that in the yellow-green curves the preference for the yellow-green has moved towards the yellow, and in the shades the selection of the red is more pronounced. A very noticeable feature in the curves for blue is the fact that they are very inharmonious with the violet. In the curves for violet the maximum falls in the yellow-green. It may be noted that the violet, as observed when the full saturation is used with tints and shades, is here also an exclusive colour. Purple combines very well with yellow-green, and in the tints with the tints also exhibits a tendency to combine with the orange.

	Shades With Shades.	Harmonize Best With	Harmonize With	Do Not Harmonize With
1	R.	YG.	(R.)	V. P. OR. B.
2	O.	YG.	O.	V. P. B. O.Y.
3	Y.	YG. and BG. R.	B. (P.)	V. Y.
4	YG.	R.	B. Y. (9) BG.	V.
5	BG.	R. Y.(9) YG. (11).	BG.	V.
6	B.	Y. (9) G.	R.	V. P. O.
7	V.	YG. Y. (9).	BG. (13) R. O. (6).	B. V. P.O. (4).
8	P.	YG. BG. (13).	R. (1).	P. R. (3) O. V. B.

	Tints With Tints.	Harmonize Best With	Harmonize With	Do Not Harmonize With
1	R.	YG.	O. Y.	P. V. B. R.
2	O.	G. (YG. and BG.).	R. (V.)	P. B. O.
3	Y.	G. R.	B. V.	Y. P.
4	YG.	R.	V. O.	YG. B. (16).
5	BG.	P. O. Y.	B. V. (21)	BG. V. (19).
6	B.	Y.	G. (12, 14).	B. V. P. (22) R.
7	V.	Y. YG. (BG. 13, 14).	P.	R. B. V.
8	P.	BG. YG. O. (4).	Y. (V.)	R. P.

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* University of Toronto Studies, Psych. Series, Vol. II, No. 2, p. 12 [94].

Having already considered these series, in which the shades are combined as constants with the tints, and the tints in combination with the shades, in reference to the question of Purkinje's law, let us now inspect the same diagrams with reference to their ability to form agreeable combinations with one another. Viewing the curves which represent each shade (three divisions to a shade) with the tints as variables, we see that red harmonizes best with the green, and very well with the orange and the yellowish-orange, but will not be found pleasant when placed beside violet, blue or purple. The next spectral quality, orange, finds its most harmonious combination in the green (12), makes a fair combination with itself (6), but will not harmonize with the violet, blue and purple, nor with the red. Shade yellow matches with the green tints (12, 13, 14), very well with the red, orange and yellow, but it does not combine well with the violet.* This is also true when the tint is the constant and the shade is the variable. Comparing the table on page 14 of the paper on colours with tints and shades, where the tints of yellow-green combine best with themselves, we are not surprised that in this case also, when the shades and tints of the same quality are used, they find their most pleasant combinations among themselves, go very well with the orange, and do not combine with the blue-green. While the blue-green in full saturation goes well with the red and with itself, when used as a shade with a tint it combines well with itself but will not harmonize with the red; and when a tint with a shade it is not pleasant in combination with the violet, and is very decided in its selection among the qualities of yellow-green, having its maximum at 12 and an "unpleasant" depression at yellow-green no. 10 (Fig. LXI. The blue in this series, like that in the colours with the shades and tints, shows a very high degree of pleasantness in combination with itself, but in this case has its maximum at the yellow-green. As to the violet, which has always been found difficult to suit, we find that it goes fairly well with itself and with orange, but best with the yellow-green (11, 12). This is also true when the tint is the constant and the shade variable. In both cases, as also in the tints with the saturated colours, it cannot be combined with red. There seems to be consistency here with our previous results in regard to the purple; for the green and yellow with their nearest neighbours are its most friendly companions, while dislike usually accompanies its combination with violet, red or blue.

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* Cf. University of Toronto Studies, Psych. Series, II. 178.

	Shades With Tints.	Harmonize Best With	Harmonize With	Do Not Harmonize With
1.1	R.	BG. YG. (not 10)	O. Y. (7)	V. B. P.
2.	O.	G. (12)	O. (6)	V. B. P. R.
3.	Y.	G. (12, 13, 14)	R. O. Y.	V.
4.	YG.	YG.	O.	BG. (15).
5.	BG.	G. (13)	B.	R.
6.	B.	YG. B.	O. (6)	V. R.
7.	V.	YG. (11, 12)	V. (19, 20) O. (6)	B. (8).
8.	P.	G. (11-13)	OY. (6, 7) R. (1)	B. V. P. R. (3).

	Tints With Shades.	Harmonize Best With	Harmonize With	Do Not Harmonize With
1	R.	YG.	Y. R.	V. B. P.
2	O.	YG.	R.	V. R. B.
3	Y.	BG.	YG. P. R. O. Y. (not 7 YO.)	V.O. (4).
4	YG.	YG.	B. P. O.	V.
5	BG.	YG. (12).	BG. Y.R. (R. P.)	V. O. YG. (10).
6	B.	G. (12, 13) B.	Y. (7)	V. P. R.
7	V.	YG. (12)	V. (19).	R. O. B.
8	P.	G. (11-13)	Y. (V.)	B. R.

As curves for three qualities added together have been made, giving the above results, it would be well to represent by diagrams the total* power of harmonious combination of each shade with all the other shades, each tint with all the tints, and similarly the series S. T. and T. S. Figs LXV to LXVIII are drawn from the totals in Tables xiii to xviii, and hence exhibit the relative agreeableness of each quality when passed through the whole series. For instance, Fig. LXV, displaying the shades, verifies in a general way what the particular curves showed in detail, viz. that yellow-green under these conditions is the most highly agreeable, while there is also considerable pleasantness in the red-purple section. The next figure gives us similar results with the tints, though with the orange and yellow sections of the curve raised to a greater height. The remaining two curves for S. T. and T. S. respectively follow the same outline, with, however, the secondary peak at orange. These four curves harmonize well with those of the other series* and with the summation curves in the series given below.

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* "Total" curves of this paper correspond to "summation" curves of the previous one, while the curves representing Tables xxvii to xxxii of this paper are called "summation curves."

Following the plan of more perspicuously representing final results by tables showing the power of aesthetic combination of each colour with the shades and with the tints, we reproduce in Tables xxvii, xxix, xxxi the totals of pleasant combinations, while Tables xxviii, xxx, xxxii give the same for the most pleasant. In order that its position may be easily located in relation to the maxima the complementary is marked with · for shades with tints, and with + for tints with shades. Tables xxvii and xxviii deal with the shades when combined with themselves, and enable us to see at a glance the comparative agreeableness of each shade. Thus it is easily observed that the violet shade is not generally acceptable in combination with other shades, and that it is relatively most agreeable when combined with the yellow-green. It is also noticeable that the yellow-green presents the greatest number of pleasant combinations and is found to be most pleasant when combined with the red. Tables xxix and xxx give a convenient survey of the field in the tints, where a similar observation as to violet may be made. A comparison of Tables xxvii and xxix with Tables ix and xi shows that while in the combinations of the colours with the tints and shades† there is a greater number of pleasant selections with the shades, for the combinations of shades and tints each with themselves the tints have the advantage to the extent of 562; that is, the total number of "pleasant" selections for the shades is 6,132, whilst that for the tints is 6,694.

Tables xxxi and xxxii report in the same manner the total results of the shades in combination with the tints. Each horizontal column shows the pleasantness of a shade combined with the spectral qualities in tints. Thus the first column exhibits the red. When combined with the tints, red has a greater affinity for itself than for blue, violet or purple, but it is inferior to the orange-yellow and the greens, its greatest pleasantness appearing in yellow-green. As a matter of fact, the only exception in this series is that of the blue-green, the maximum being with another saturation of its own colour. To the fact of yellow-green and blue-green being most harmoniously combined with themselves there is no analogy in the experiments in the colours with the tints and shades, nor in those of the tints and shades each with themselves. In every-day life, greens of different intensity and saturation occur frequently side by side, as in exterior and interior house decoration and in costumes.

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* Cf. Baker, op. cit., Combination Curve, Fig. XXXVIII, and Figs. XXI, XXII, of University of Toronto Studies, Psych. Series, Vol. II, No. 3.

† University of Toronto Studies, Psych. Series II. 183-184.

Each perpendicular column records the number of judgments in favour of a tint as constant with the shades as variables. For instance, although when the violet is a shade we find the number of judgments in favour of its combination with yellow-green to be 132, yet we see its aesthetic value increases almost 25 per cent. (to 160) when it is used as a tint with the shades. It is even more pronounced in the "most pleasant" Table xxxii. When saturated colours in combination with shades were under consideration we found that orange and yellow had the preference, and when colours were combined with tints the greatest agreeableness was at blue-green and violet. But at present, when we combine shades and tints with one another, we find the maxima at yellow, yellow-green and blue-green. The orange shade agrees to some extent with its own tint, but appears best in company with the yellow-green. A similar statement may be made regarding the violet and the blue. The purple has the maximum at the yellow-green, while it does not harmonize with itself. No comparison of these cases in which the qualities combine well with themselves can be made with the corresponding totals in Tables xxvii to xxx, because in Tables xiii to xvi, from which they were taken, the numbers which represent identical qualities were ignored, on account of the same colour in the same intensity not forming a binary combination.

These tables have been diagrammatically represented in Figs. LXIX to XCII, where the movement of the maxima and the relative aesthetic values of qualities may be more easily followed. The S. S. curves are drawn from Tables xxvii and xxviii, the T. T. figures from xxix and xxx. The remaining curves

(LXXXV to XCII), taken from Tables xxi and xxxii, exhibit the S. T. and T. S. series. The plain curves, showing the shades as constants, correspond to the horizontal columns of the tables, while the dotted lines for the shades as variables are taken from the perpendicular columns.

TABLE XXVII

SHADES

PLEASANT

Shades.	R.	O.	Y.	Y.G.	B.G.	B.	V.	P.	Shades
R	54	76	131	225	146 ×	74	56	48	810
O..........	76	74	87	170	104 ×	65	49	44	669
Y	131	87	66	167	140	116 × +	73	102	882
Y.G	225	170	167	118	142	146	+ 102	155 ×	1225
B.G	146 +	104 +	140	142	80	112	63	+ 109 ×	896
B	74	65	+ 116 ×	146	112	34	28	53	628
V	56	49	73	102 ×	63	28	30	36	437
P..........	48	44	102	+ 155	109 × +	53	36	38	585
									6132

TABLE XXVIII

SHADES

MOST PLEASANT

Shades.	R.	O.	Y.	Y.G.	B.G.	B.	V.	P.	Shades
R.	8	15	29	73	51 ×	21	11	16	224
O.	15	26	16	63	26 ×	10	10	8	174
Y.	29	16	12	32	27	31 × +	21	27	195
Y.G.	73	63	32	32	27	33	33 +	53 ×	346
B.G.	51 +	26 +	27	27	12	23	17	30 + ×	213
B.	21	10	31 + ×	33	23	6	5	5	134
V.	11	10	21	33 ×	17	5	14	11	122
P.	16	8	27	53 +	30 × +	5	11	14	164
									1572

TABLE XXIX

TINTS

PLEASANT

Tints.	R	O.	Y.	Y.G.	B.G.	B	V.	P.	Tints.
R	36	111	136	175	143 ×	73	40	15	729
O	111	56	106	156	159 ×	90	101	70	849
Y...........	136	106	64	140	151	135 × +	128	113	973
Y.G	175	156	140	90	122	119	140 +	133 ×	1075
B.G	143 +	159 +	151	122	88	126	123	141 + ×	1053
B	73	90	135 + ×	119	126	54	53	72	722
V	40	101	128	140 ×	123	53	34	58	677
P	15	70	113	133 +	141 × +	72	58	14	616
									6694

TABLE XXX

TINTS

MOST PLEASANT

Tints.	R.	O.	Y.	Y.G.	B.G.	B.	V.	P.	Tints.
R	4	16	21	37	37 ×	13	2	0	130
O	16	12	19	34	45 ×	31	24	14	195
Y	21	19	18	19	36	27 × +	26	18	184
Y.G	37	34	19	24	25	20	+ 31	32 ×	222
B.G	37 +	45 +	36	25	40	36	39	+ 63 ×	321
B	13	31	+ 27 ×	20	36	10	12	23	172
V	2	24	26	31 ×	39	12	12	17	163
P	0	14	18	+ 32	63 × +	23	17	10	177
									1564

TABLE XXXI

SHADES WITH TINTS

PLEASANT

Shades.	R.	O.	Y.	Y.G.	B.G.	B.	V.	P.	Tints.
R	91	121	128	161	143 ×	52	37	47	780
O	89	128	119	154	121 ×	76	58	77	822
Y	136	137	152	150	159	122 × +	101	120	1077
Y.G	182	200	195	233	178	155	160 +	166 ×	1469
B.G	93 +	139 +	154	189	202	146	119	130 + ×	1172
B	67	106	124 + ×	169	145	155	83	65	914
V	63	91	96	132 ×	103	94	108	81	768
P	72	110	129	165 +	136 × +	43	51	61	767
	793	1032	1097	1353	1187	843	717	747	7769

If read horizontally the Table shows S. constant, T. variable; if vertically, vice versa.

TABLE XXXII

SHADES WITH TINTS

MOST PLEASANT

Shades.	R.	O.	Y.	Y.G.	B.G.	B.	V.	P.	Tints.
R..........	23	31	24	48	36 ×	7	6	16	191
O..........	20	36	31	51	21 ×	9	4	10	182
Y..........	40	19	35	34	29	23 × +	22	42	244
Y.G.........	64	67	60	85	53	45	+ 59	76 ×	509
B.G	25 +	19 +	25	47	66	43	28	+ 37 ×	290
B..........	19	26	+ 13 ×	33	32	35	24	14	196
V	18	6	12	32 ×	25	20	30	20	163
P	23	24	14	+ 47	40 × +	8	13	10	179
	232	228	215	377	302	190	186	224	1954

If read horizontally the Table shows S. constant, T. variable; if vertically vice versa.

We have already explained, when describing our method of experiment, that in the instructions to the observers it was emphatically stated to be essential to the success of the experiments that they should abstain from any association of the colours under examination with persons, things or events. It is needless to ask why a certain sensation or combination of sensations is accompanied by a certain aesthetic tone, for to attempt to answer this by stating that the feeling of like (or dislike) is associated with a sensation in another field would simply be to shift the problem from the first field to the second and then to be confronted by it in another form. If it be said that the reason one prefers the colour orange to that of violet is that our ancestors found the fruit which bears the colour (and the name) pleasant to the taste, and that therefore one has evolved a liking for the colour, it is apparent that we have now the problem, Why did our parents like the fruit? The same difficulty in answering why one likes a colour presents itself as to why one likes a taste, therefore perhaps no one would be so unwise as to suggest that all preferences for certain colours have been similarly developed from some particular sensuous field; for it may be suggested that on the same ground our foreparents' enjoyment of the violet-coloured plum would not have given them such a peculiarly restricted pleasure in the violet sensation. Further, the violet colour has another advocate in the sense of smell, gratified by the flower of the same name. If we are to trace the pleasure of one sense to that of another, why should not smell, which undoubtedly has played and does play such an important part in animal life, instead of taste be regarded as the original? And if, on the other hand, both taste and smell are responsible for the affective quality of the violet colour, with so much in its favour we should expect it to be less exclusive. It requires but slight thought on the question to see that it is often quite true that a pleasant sensation in one field is joined by nature to even an unpleasant one of some other sense. It has been said that ease in pronunciation is one formative factor in the development of language, while the selection of pleasant sounds, i.e. what is called "taste," is another. This means that the feeling-tone accompanying the sensations experienced in pronouncing certain syllables has its influence upon the second attempt to produce the same or a similar sound, and this in course of time produces by "natural selection" that sound with whose articulation there is associated the least disagreeable feeling (the greatest "ease"). As to "taste," a similar statement may be made. "Taste" is the affective tone accompanying the sensations heard, whether individual or in combination. Now, to explain "ease" in terms of "taste" (or vice versa), or to give one as a reason for the other, would only complicate the question. It is quite conceivable that the two should even be at variance, that is, that a word which is difficult to pronounce might be euphonious, or that one spoken with ease should be inharmonious, e.g. "onomatopoetic" and "disk."

respectively. A similar difficulty confronts him who would say either that on account of unpleasant associations yellow is not pleasant, or that the pleasantness of orange is due to the fact that that colour happens to be the colour of the fruit. First, it is not only untrue that the golden sun is unpleasant, but also is it false to say that yellow as a component in combinations is not of great agreeableness. This is shown by experiment.* Second, who would assume that the orange colours, tints and shades as combined in the sunset derived their beauty from the eating of the orange? And again, if "the taste for colour . . . must all be originally referred to the habits of our frugivorous ancestors,"† how can the fact, demonstrated by our experiments, be explained, namely, that not the colours of ripened fruits, but the colour most frequently met with in nature —that of the foliage and unripe fruit (yellow-green)—stands highest in aesthetic value when shades and tints are used, as is strikingly indicated in the summation curves LXIX to XCII? These figures also show that the red (in combinations consisting of shades and tints) is most frequently selected, when combined with the green.

If pleasantness of a colour is to be accounted for by its prevalence, support may be found in the facts of nature. Though the persistence of a colour may become wearisome, when a limited period of time is considered, as when one continuously gazes at a particular colour-combination, yet it will be found that the common colours are generally acceptable. This is not so surprising in reference to colours when we remember that it also applies to other aspects of life. It is said that we like what we know best,—the familiar tunes, poems, scenes and people. The results of our experiments show that so far as the affective quality accompanying colour-combinations is concerned, the omnipresence of yellow-green in its various shades and tints in the foliage is most highly appreciated. The prevalence of yellow in the sun, the stars, and in the complexion of a great part of the human race is in harmony with the high degree of pleasantness of that colour-quality, while the incessant appearances of orange in the sunsets and in the ripened grain are universally agreeable. It is true, however, that any such comparisons involve not only quality of colour but an infinite variety of conditions of size, shape, background, intensity and saturation. It is interesting to observe the relation of agreeableness and frequency of occurrence not only of certain colours but of combinations of such colours as yellow and blue in the sky and stars, as red or orange of fruits and yellow-green of the leaves, for throughout the varied series of our experiments the great pleasantness of these combinations is evident. (See Tables ix to xii and xxvii to xxxii.)

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* *Vide* Baker, op. cit., Fig. XXXVII, combination curve for saturated colours, and University of Toronto Studies, Psych. Series II. 183-184, for colours with tints and with shades.

† Grant Allen, *The Colour Sense : Its origin and development*, p. 281.

While curves XXXI to XXXIX represent the relation of the maxima of pleasantness to the complementaries, it is yet desirable to combine these curves in such a way as to be able to compare the different series with regard to this relation, that is, we wish to view more perspicuously the changes in the maxima corresponding to the intensity changes through the five series from tints with themselves through C. T., T. C., C. C., C. S., S. C., to shades with themselves. In Figs. XCIII to CXVI each of the 24 curves shows one of the 24 colour-qualities, through the five series. The abscissa shows the point in the colour-manifoldness at which each maximum of the different series falls, while the ordinate shows the intensities. The perpendicular line cutting the curve represents the position of the complementary. The curve, therefore, not only exhibits the relative positions of the maxima in the different intensities, but also their relation to the complementary colour. High peaks not maxima are marked thus (×), whilst lesser prominences are marked thus (v).

(1) Curve XCIII shows us, in regard to red number 1, that the complementary falls in the blue-green toward the blue, and that the maxima in the five series are situated as follows: In the tints with themselves the maximum is at green: when the colours are combined with the tints it shifts toward the yellow-green with minor peaks in the adjacent qualities and in the purple or red. In the colours with themselves the maximum is again in the yellow-green shifted in the direction of the yellow. In the fourth series it stands in the yellow itself (with minor maxima in the green) indicating that the change of intensity

from series to series is compensated by the movement from the darker green to the lighter yellow, but the next move in the shades with themselves takes us back to our starting-point in the green. This compensation may be seen in the two following figures, which represent the reds of numbers 2 and 3.

(2) In the three curves for the orange the maxima of the first correspond very well with those in the curve for red, but there is an apparent change in the other two (Figs. XCVII, XCVIII). In the latter the finest combinations among the colours with themselves are found in the violet and purple, a tendency toward these colours being already indicated in Fig. XCVI. However, a glance at the original curves, in Baker's work, will show that there is not a great difference in height between the peaks for the violet and those for the yellow-green.

(3) The three curves for the yellow show a wide range of selections, with a preference for the red, purple and blue-green sections. There is an exception in the tints and shades with themselves, where there are no marked elevations in the purple. In the colours with themselves there is a decided preference for the blue, but in the colours with the shades, and the shades with themselves, the maxima are in the yellow and yellow-green respectively.

(4) The three figures for yellow-green show a transition from yellow-green in the colours with tints to red in shades with themselves. In the combinations of tints and colours there are high prominences at both the red and the green, but in the saturated series the highest peaks stand at red, red and yellow, respectively, for the three curves. The fourth series has greater diversity. The shades with themselves have two points of great pleasantness, viz. red and yellow-green.

(5) The zigzag lines for the blue-green in the two figures, CV and CVII, are due to the quality-contrast in the tints, colours and shades, each with themselves, being replaced by the contrast of intensity in the series tints and shades with the colours. Whilst the line for the maxima in the middle blue (Fig. CVI) does not have the same shape as those of the other two blues, yet a line joining the points of high preference would resemble them. The great pleasantness in series four (C. S.) at the

purple section is a feature also seen in the curves for yellow-green, blue-green and blue.

(6) In the blue the zigzag curves are quite regular (if the points of high preference in Fig. CVI, C. S., be included in the curve). The bases of the two triangles are in the warm complementary yellow, and their apices in the cold part of the spectrum. (See discussion above in reference to complementary curves for blue, p. 25, rule 3.)

(7) The triangular features remain in the violet curves, though in the shades with the colours there are also maxima at the left of the complementary. The apices here fall at violet (and in C. S. at yellow-green also), and the bases of the triangles at or near the yellow. It may be stated here that, though we have not shown in these curves the positions which the maxima of the series shades with tints, and vice versa, would occupy, they definitely corroborate the testimony of those series above in which there is considerable intensity-contrast (viz. colours with shades and tints), that intensity-contrast may replace that of quality.

(8) In reference to the curves for purple, we observe that they are similar to those for violet, though they differ in the fourth series (S. C.), where in the curve for purple the maxima fall within the yellow and green.

In reference to the relation of red and green a series of experiments upon two "colour-blind" persons may be reported here. After a variety of tests, both were found to be abnormal in their judgments regarding red and green—apparently being dichromates with the neutral zone in the green. One observer chose a rose-coloured yarn to indicate the colour of the clear sky, the other not distinguishing the red flowers from the foliage, while both manifested a liking for bright red neckties and clothes of more or less dark green shades. When the series of saturated colours (combined with themselves) was exhibited, the colours chosen most frequently as pleasant were just those in which the abnormality manifested itself. The results of the trials are shown in curve CXVII, drawn similarly to those for normal observers. Why red and green, which they often do not distinguish, should be chosen as the agreeable sections of the spectrum, it is difficult to say. Aside from the question why certain affective tones accompany certain colours and their combinations, we have here the problem, What is the colour? If it cannot be demonstrated that two normal persons looking at the same coloured card under similar circumstances and calling it by the same name, e.g. red, do really see the same quality, much less can it be shown what quality other persons see who act and speak of it in an unusual manner, i.e. whom we call "colour-blinds." We can only interpret their words in terms of our own colour-experience. If their red and green were as our grey, we might expect their choices to correspond, to some extent, with Chown's results with greys. On the contrary, her maxima are decidedly at red and blue. If where we see red and green they see a colour of diminished or increased intensity, we should not be surprised if the curves were more closely to follow the figures above where difference of intensity is evident, e.g. S. T. and T. S. (Figs. LXXXV to XCII), where red is less prominent. The selections made rather correspond to the curves for shades with themselves where the red is of high value (Figs. LXIX to LXXVII).

SUMMARY.

1. The present experiments tend to confirm Miss Baker's conclusion that the traditional view regarding the preference for complementaries in colour combinations is unfounded. However, the case of yellow and blue demands some special consideration, perhaps on account of the remaining intensity contrast between those colours when the contrast of saturation has been eliminated.

2. In trials other than those with fully saturated colours the yellow yields its general pre-eminence to yellow-green, though in those series which combine saturated colours with tints or shades both yellow and green are prominent.

3. There seems to be a consensus of judgment that colours of great contrast (though not complementaries) and colours of small intervals form pleasant combinations. (*a*) When there is a considerable intensity and saturation contrast the tendency is toward the small interval of quality (e.g. shades with tints, etc.). (*b*) When the saturation contrast is practically eliminated and the intensity contrast largely reduced, for instance, in colours, tints or shades each combined with themselves, the wide interval aesthetically predominates (e.g. between yellow-green and red). The remaining intensity difference between yellow and blue, when these colours are of equal saturation, seems to add to, rather than to replace, the value of the quality contrast, thereby giving the above-mentioned peculiarity. This conclusion may throw some light upon Kirschmann's statement that our sense of sight seems to find pleasure in combinations with a great contrast effect, to which Külpe makes reference in his report.[*] Kirschmann also claims that small quality intervals are pleasant.[†]

4. Our trials show conclusively that Purkinje's phenomenon plays an important rôle in the selection of pleasant combina-

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[*] *Bericht über den II. Kongress f. exp. Psych.*, p. 27.

[†] University of Toronto Studies, Psych. Series I. 415, footnote.

tions throughout the different series. The present investigation of the phenomenon gives definite information in reference to Brücke's contention that " small intervals please if the distribution of intensity and the difference of quality correspond to the natural effect of shadow."*

5. The polar sections appear to be yellow adjacent to the green, and violet-blue, instead of yellow or orange-yellow, and blue (as in Miss Baker's paper).

6. The present experiments not being confined to highly and equally saturated colours as in Miss Baker's work, but including variety of intensity and of saturation, may be applied more widely to practical purposes, though there is yet to be considered the influence of variation of size, shape and position. These further possibilities are now being investigated in the Psychological Laboratory.

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* Baker, op. cit., p. 37.

VITA.

I, Frank Louis Barber, was born at Waterford, Ontario, in the year 1877, where I received instruction in the Public and High Schools until 1894. Having qualified in that year, I taught in the Public School in my native town till 1898, at the same time completing the work of the first year in Arts at the University of Toronto, and also writing the preliminary examination to the ministry of the Methodist Church. The following year was spent at Victoria University in Theology and in the University of Toronto in Philosophy. The years 1899–1901 were occupied in preaching and in study, after which two years were spent at the University in the departments of Philosophy, Theology and English. Graduation in 1903 as a Bachelor in Arts at the University of Toronto was followed by a fourteen months' tour of Europe, Egypt and Palestine. In 1905 I obtained the degree of Master of Arts for research work in Experimental Psychology (Colour Aesthetics), graduated in Theology at Victoria University, and was ordained into the Methodist ministry. The teachers in Philosophy, under whom I have been privileged to work, are Prof. J. Gibson Hume, Prof. A. Kirschmann, the late Rev. Prof. E. I. Badgley, Prof. F. Tracy, Dr. A. H. Abbott; in English, Rev. Prof. A. H. Reynar; in Political Philosophy, Prof. James Mavor; in Theology, Rev. Chancellor N. Burwash, Rev. Prof. McLaughlin, Rev. Dean F. H. Wallace, Rev. Prof. J. Burwash.

While Instructor in the University of Toronto, I have continued my work, previously begun, in Colour Aesthetics. Having taken Ethics and Political Philosophy as minor subjects, I now beg to submit for examination in the major subject, Psychology, the present thesis on "Colour Aesthetics: Combinations of Colours, Tints and Shades," which is the result of three years' experimentation in the Psychological Laboratory of Toronto, under the direction of Professor Kirschmann.

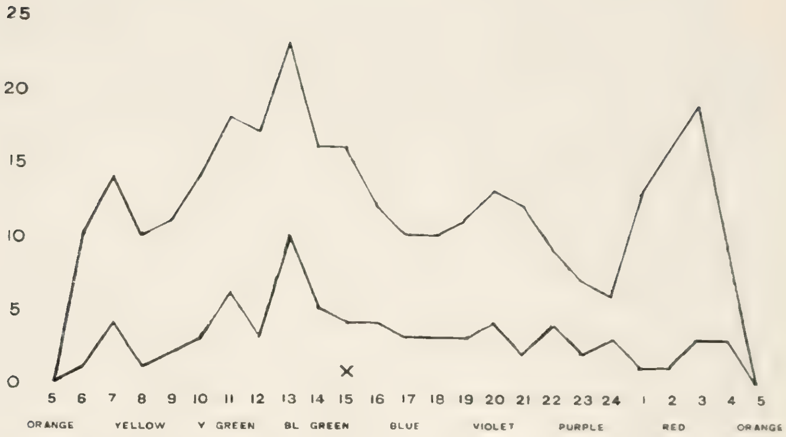


FIG. XXIII.—ORANGE, TINT 5 WITH TINTS

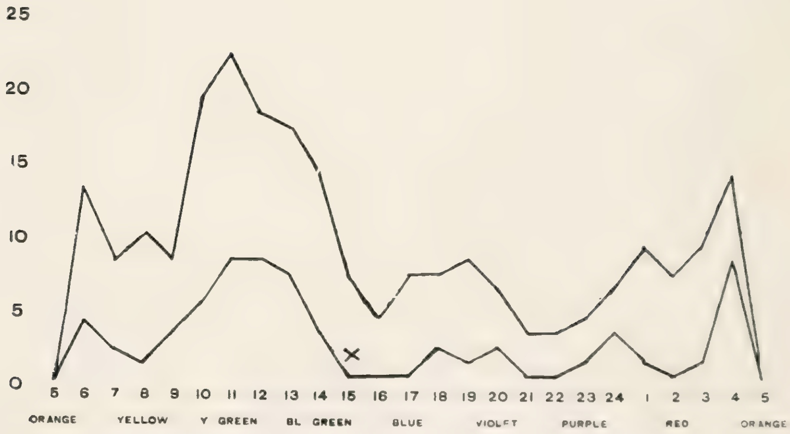


FIG. XXIV.—ORANGE, SHADE 5 WITH SHADES

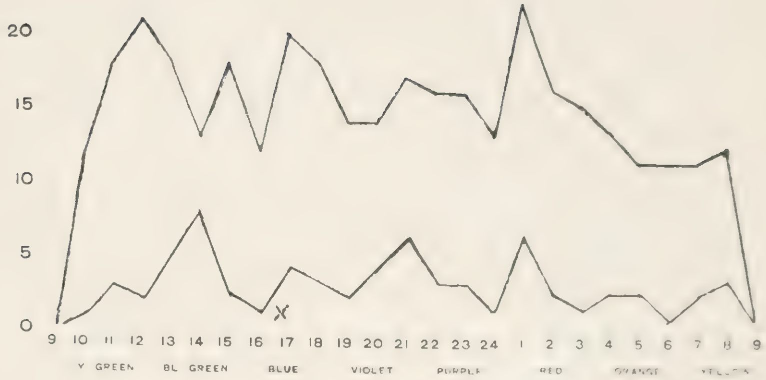


Fig. XXV.—Yellow, Tint 9 with Tints

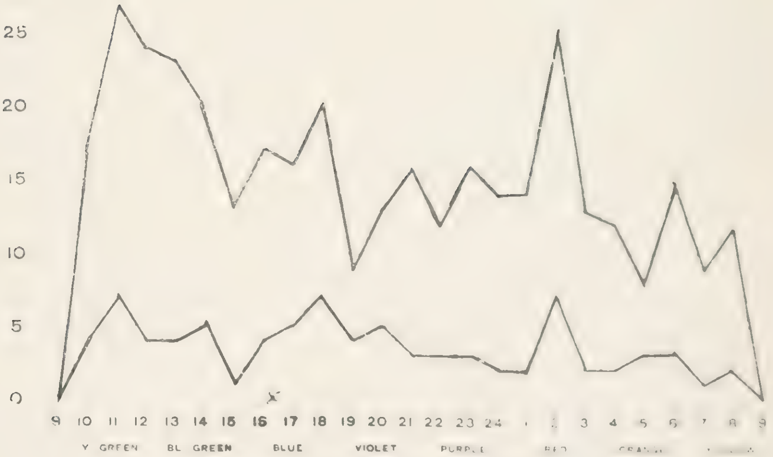


Fig. XXVI.—Yellow, Shade 9 with Shades

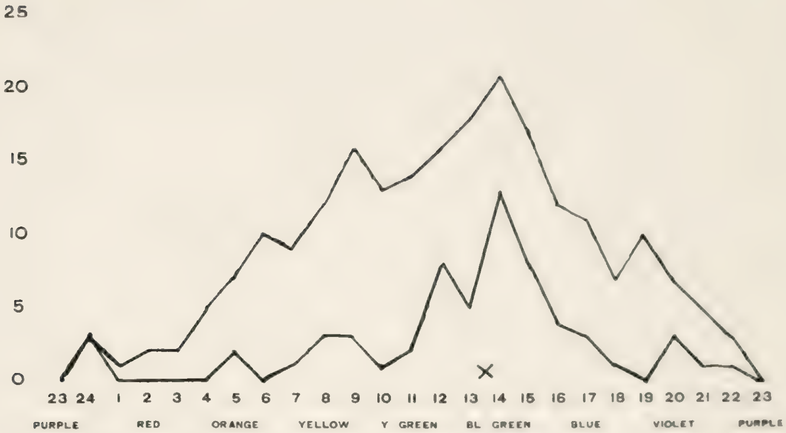


FIG. XXVII.—PURPLE 23, TINTS WITH TINTS

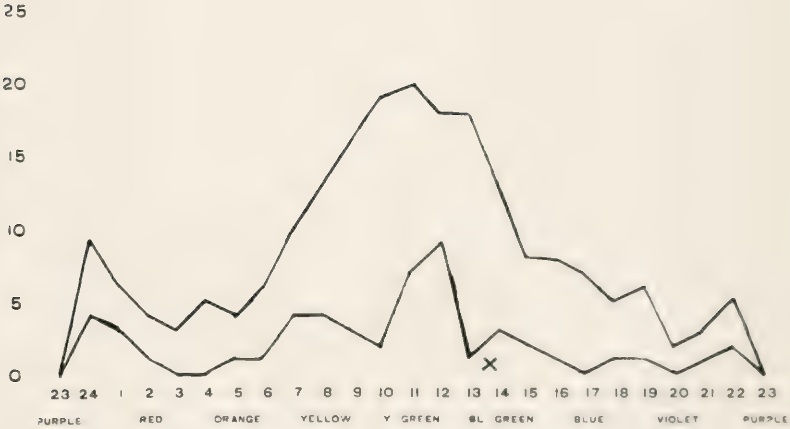


FIG. XXVIII.—PURPLE 23, SHADES WITH SHADES

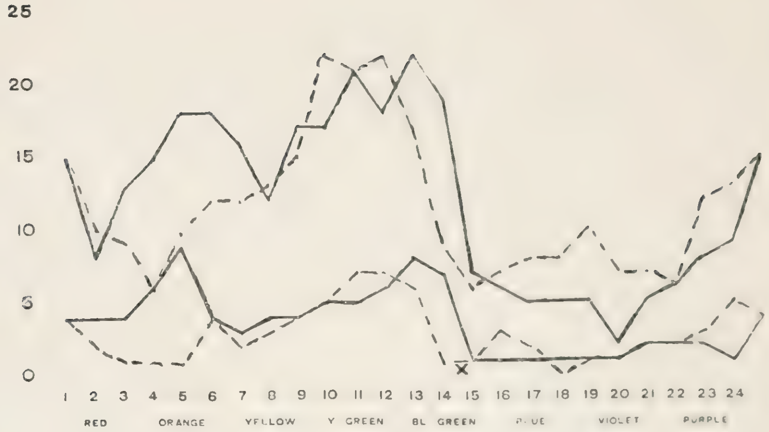


FIG. XXIX.—RED 1, SHADES AND TINTS

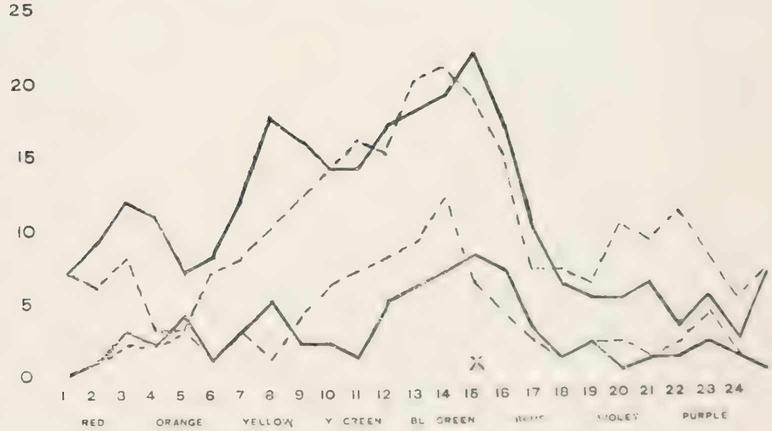


FIG. XXX.—PURPLE 23, SHADES AND TINTS

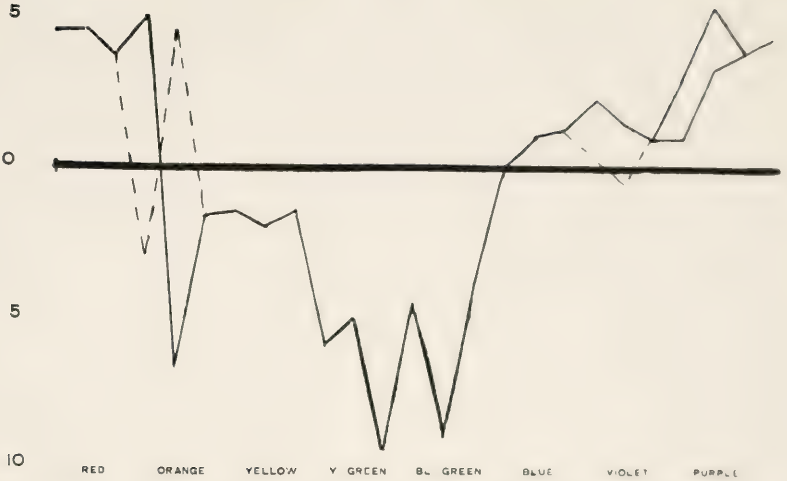


FIG. XXXI.—COLOURS WITH COLOURS

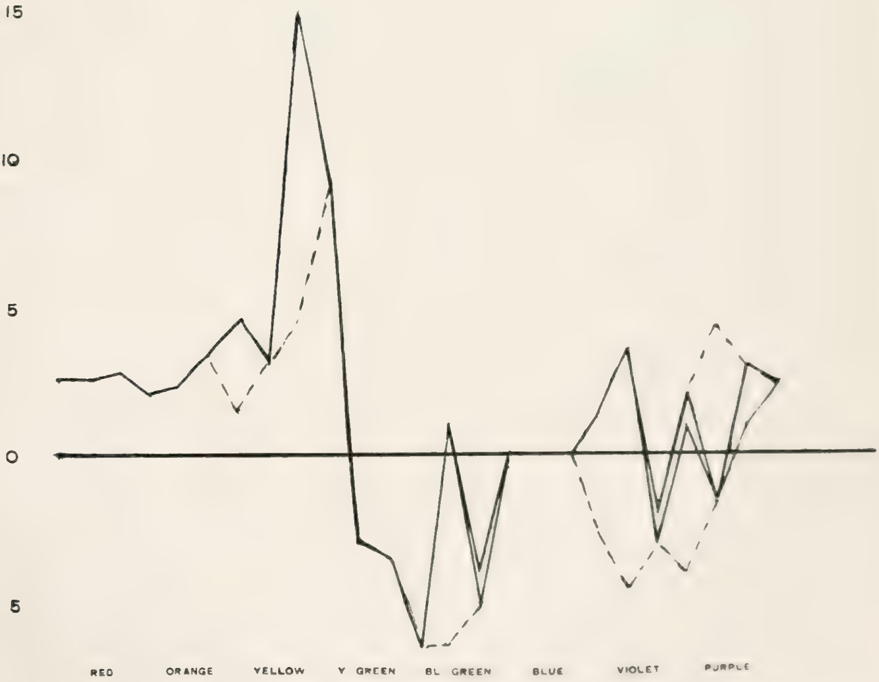


FIG. XXXII.—TINTS WITH TINTS

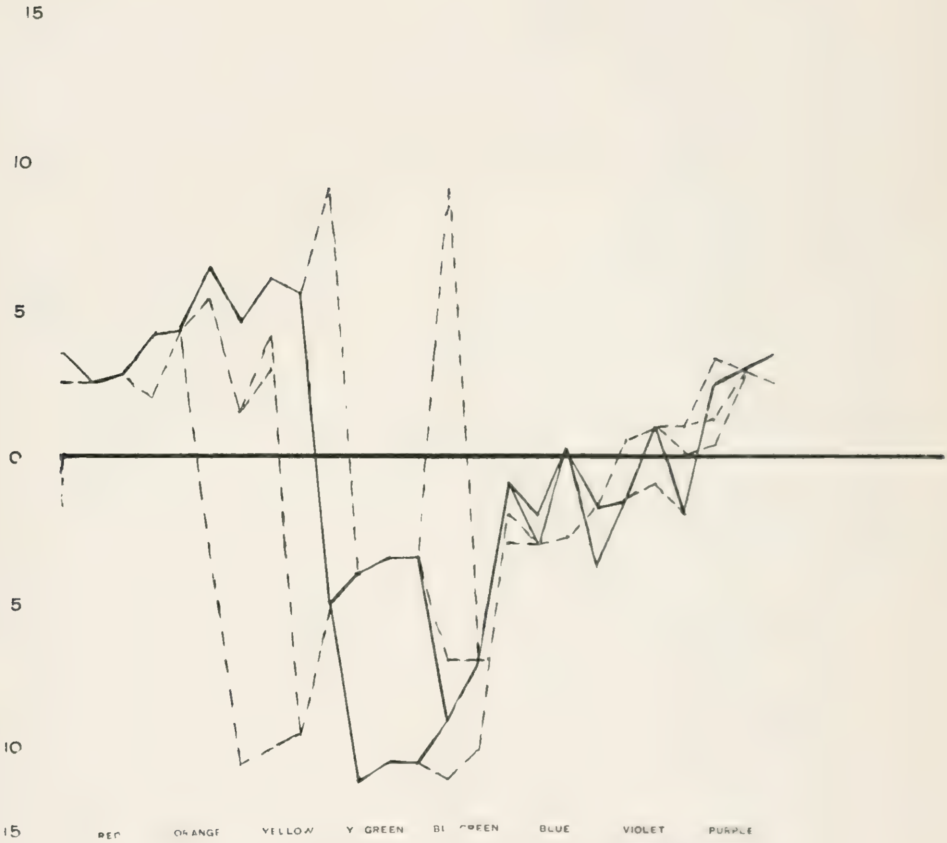


FIG. XXXIII.—SHADES WITH SHADES

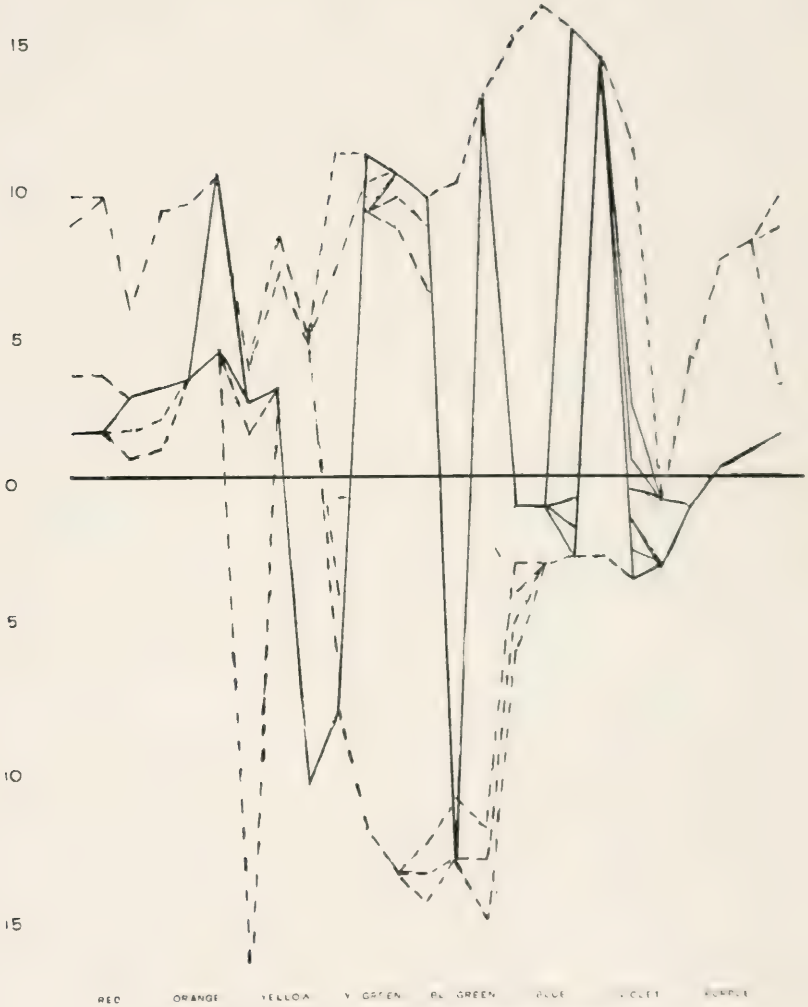


FIG. XXXIV.—SHADES WITH TINTS

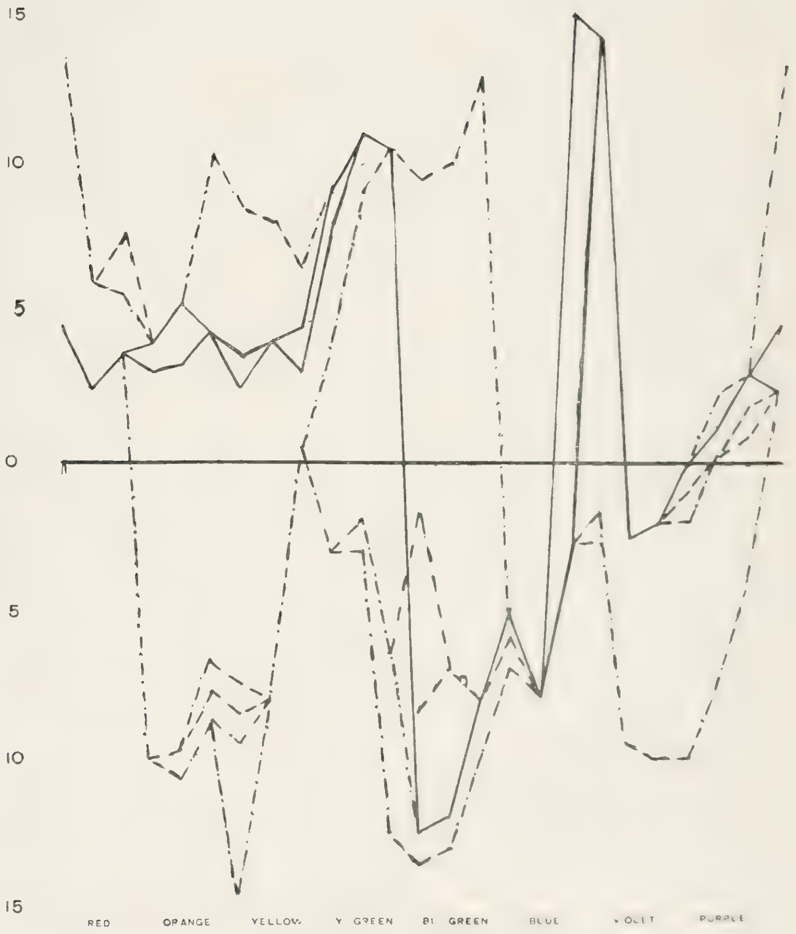


Fig. XXXV.—Tints with Shades

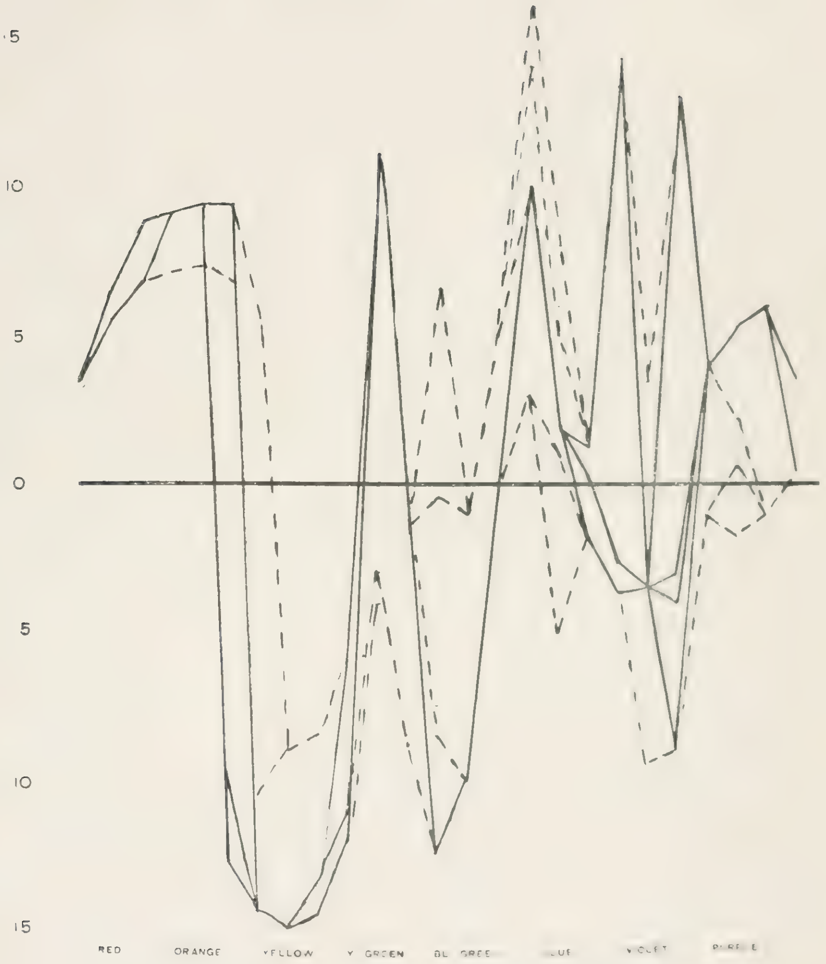


FIG. XXXVI.—COLOURS WITH SHADES

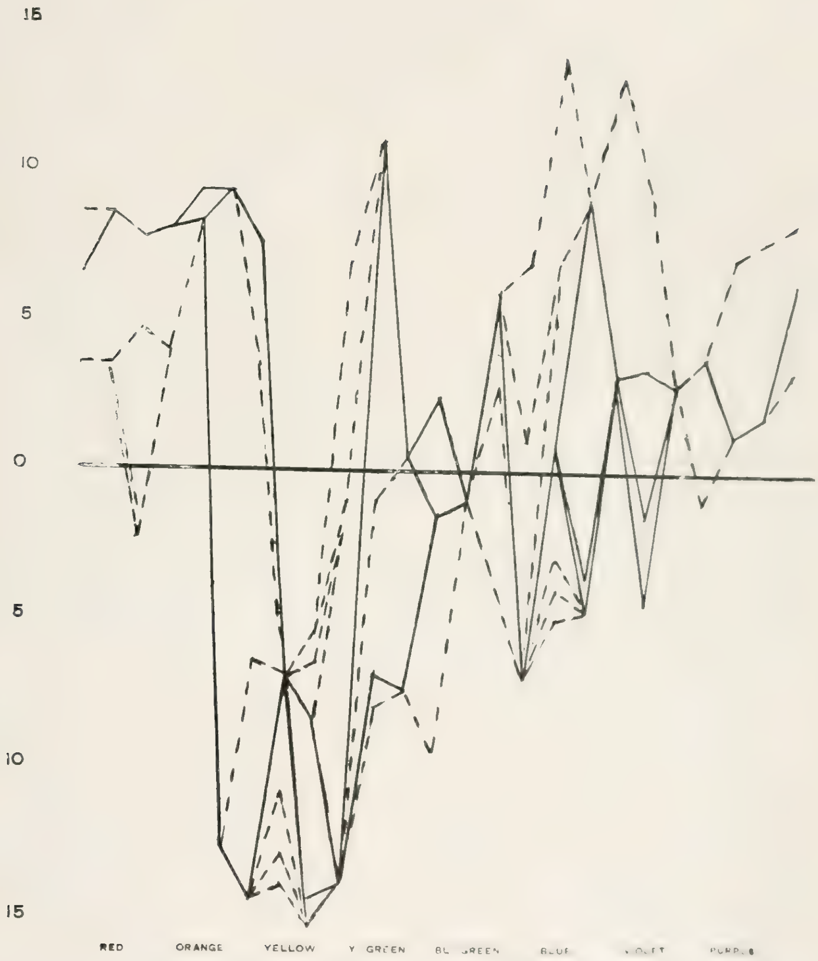


FIG. XXXVII.—SHADES WITH COLOURS

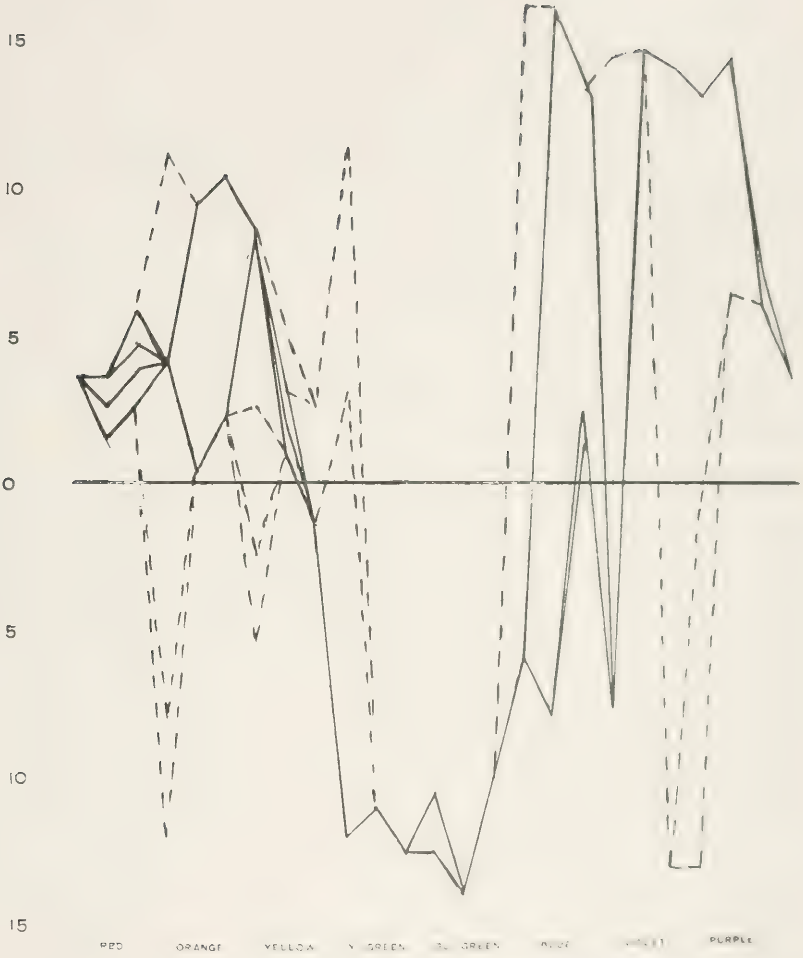


FIG. XXXVIII.—COLOURS WITH TINTS

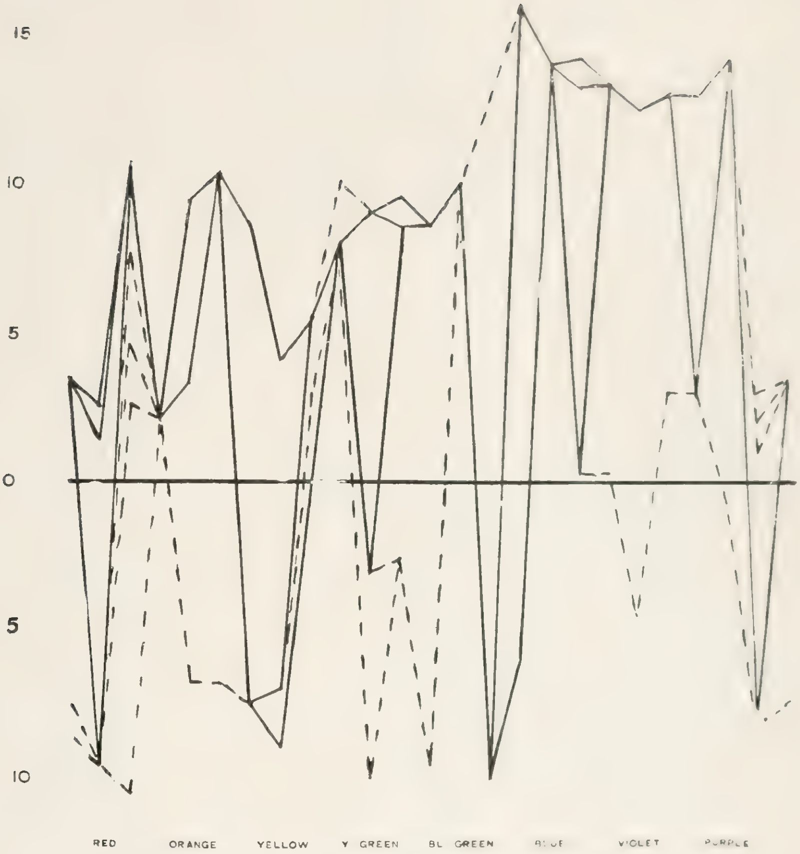


Fig. XXXIX.—Tints with Colours

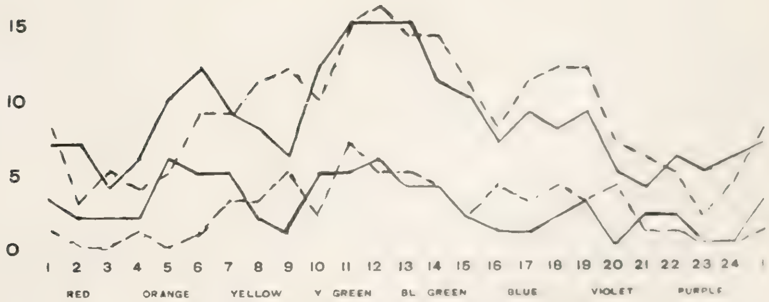


Fig. XL.—Intensity Contrast

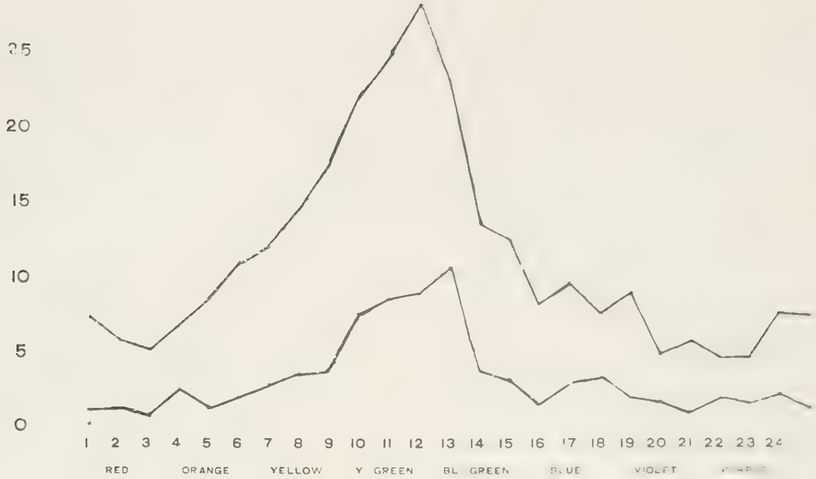


Fig. XLI.—Red, Shades 1, 2, 3

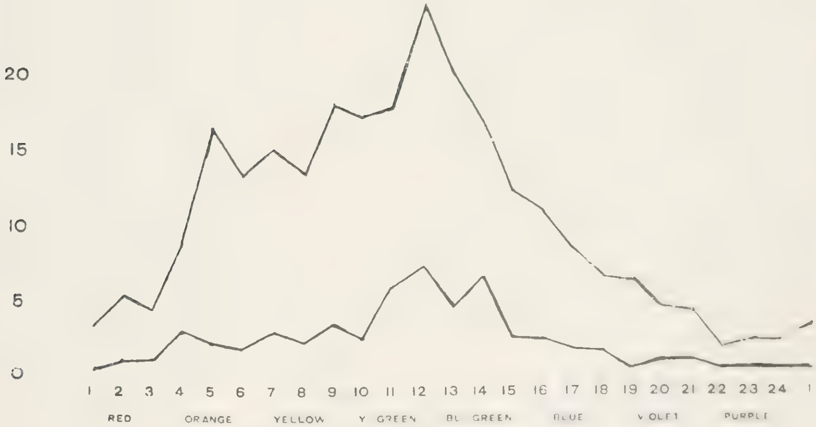


Fig. XLII.—Red, Tints 1, 2, 3

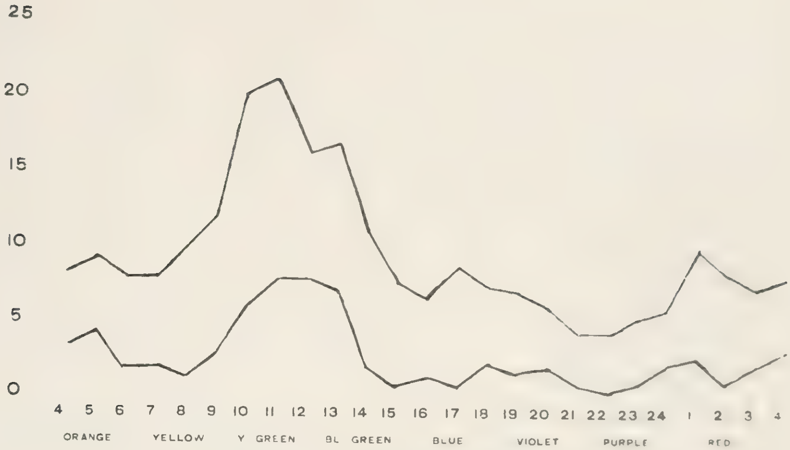


FIG. XLIII.—ORANGE, SHADES 4, 5, 6

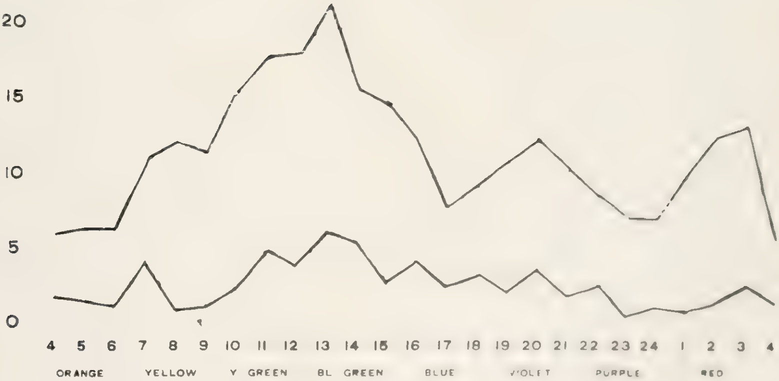


FIG. XLIV.—ORANGE, TINTS 4, 5, 6

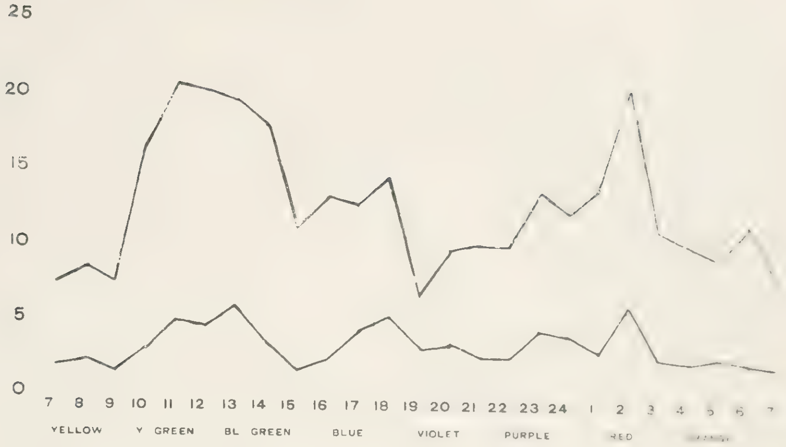


FIG. XLV.—YELLOW, SHADES 7, 8, 9

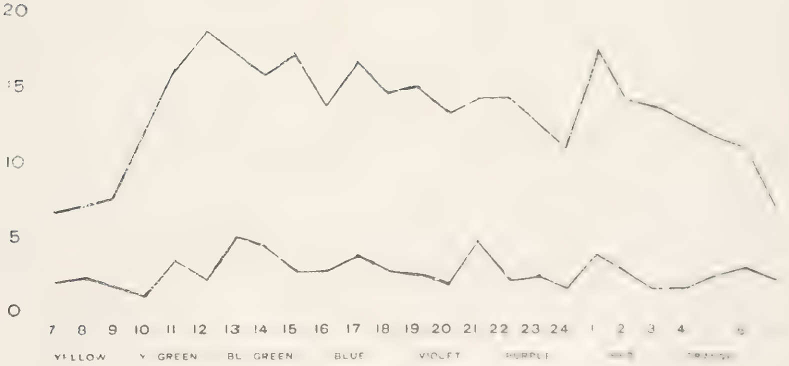


FIG. XLVI.—YELLOW, TINTS 7, 8, 9

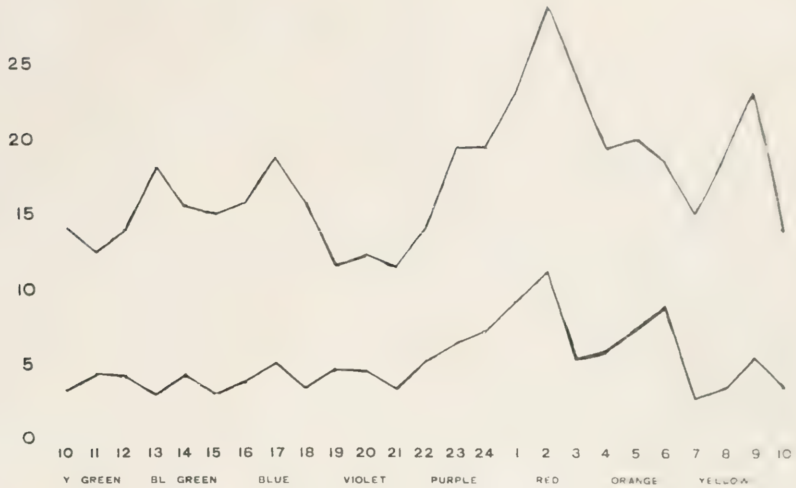


FIG. XLVII.—YELLOW-GREEN, SHADES 10, 11, 12

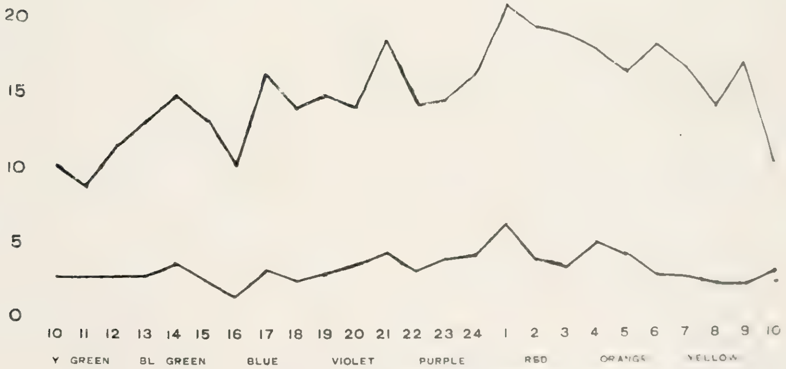


FIG. XLVIII.—YELLOW-GREEN, TINTS 10, 11, 12

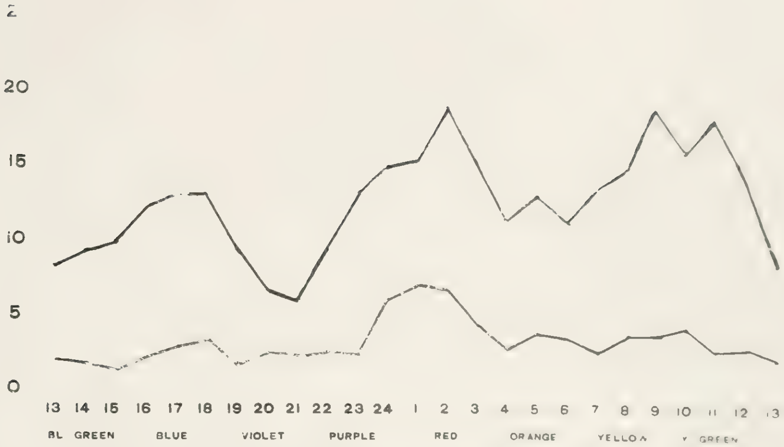


Fig. XLIX.—Blue-Green, Shades 13, 14, 15

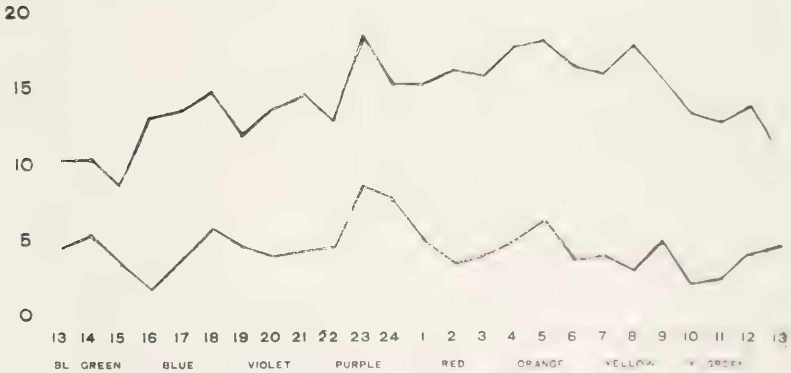


Fig. L.—Blue-Green, Tints 13, 14, 15

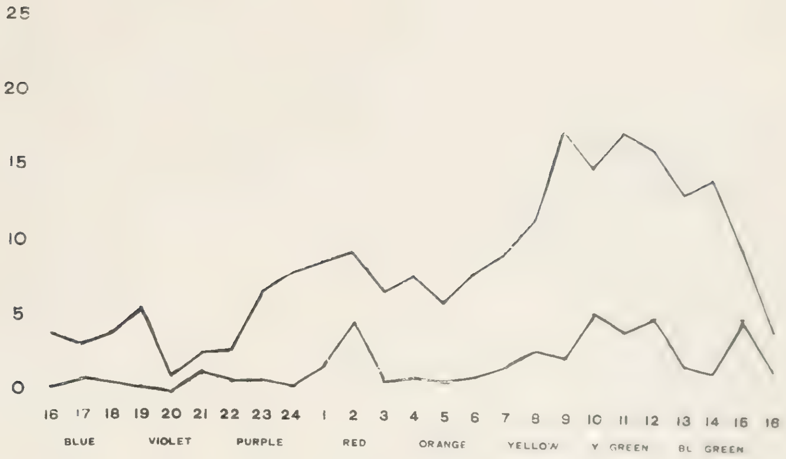


FIG. LI.—BLUE, SHADES 16, 17, 18

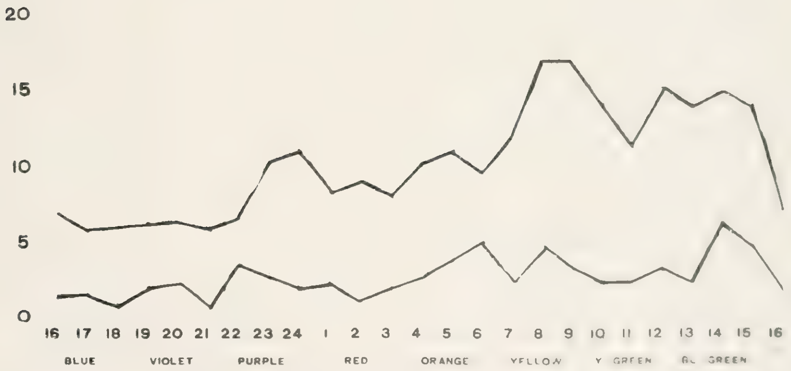


FIG. LII.—BLUE, TINTS 16, 17, 18

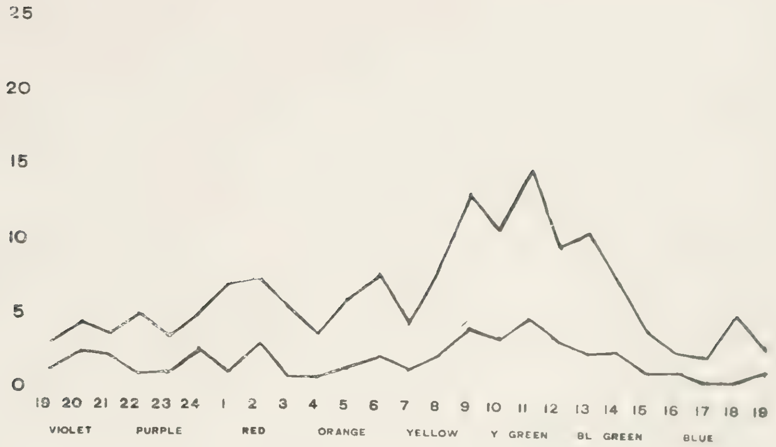


FIG. LIII.—VIOLET, SHADES 19, 20, 21

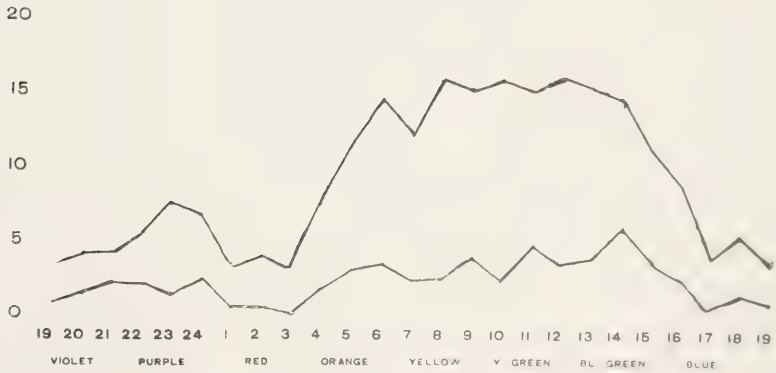


FIG. LIV.—VIOLET, TINTS 19, 20, 21

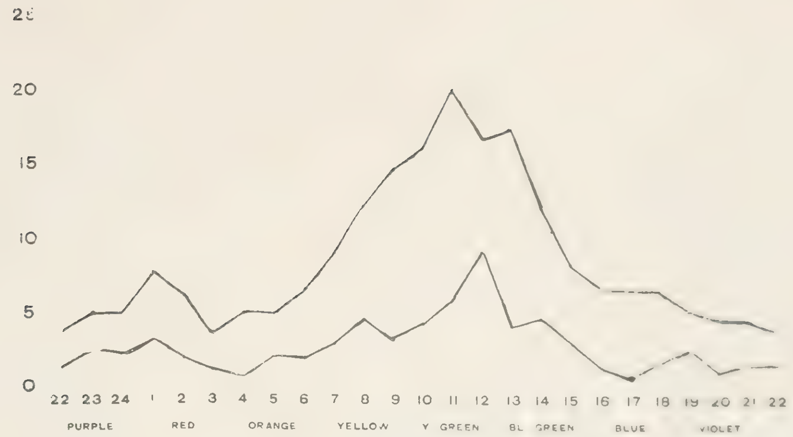


FIG. LV.—PURPLE, SHADES 22, 23, 24

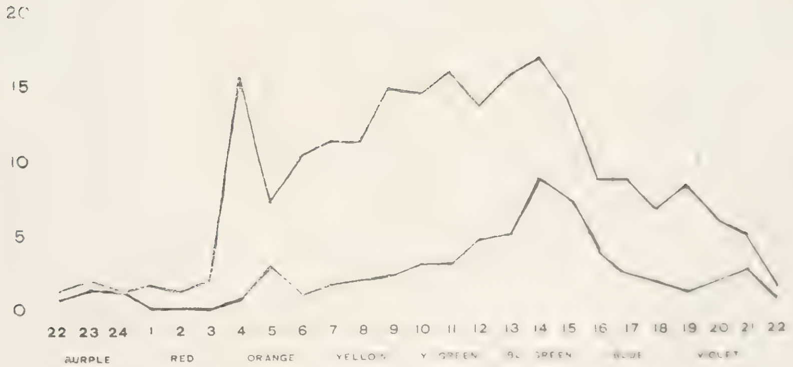


FIG. LVI.—PURPLE, TINTS 22, 23, 24

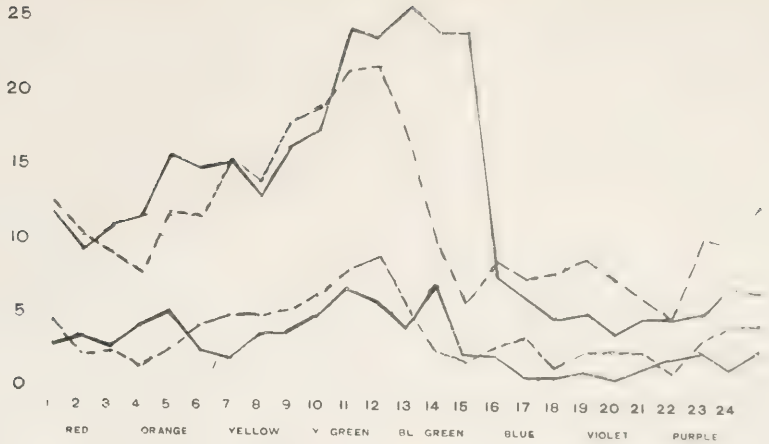


Fig. LVII.—Red, Shades and Tints 1, 2, 3

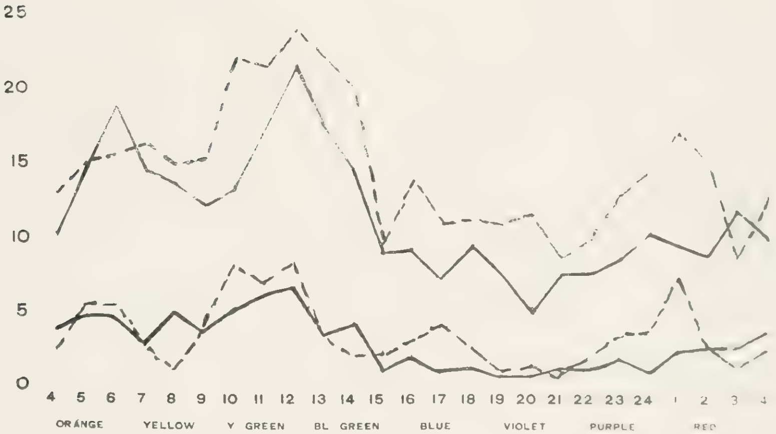


Fig. LVIII.—Orange, Shades and Tints 4, 5, 6

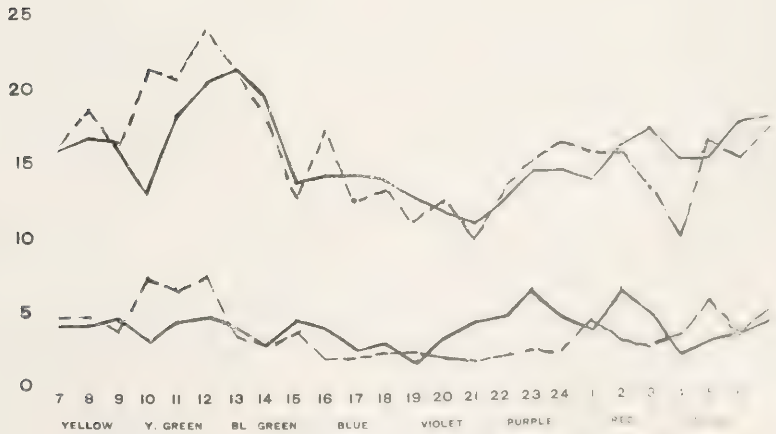


Fig. LIX.—Yellow, Shades and Tints 7, 8,

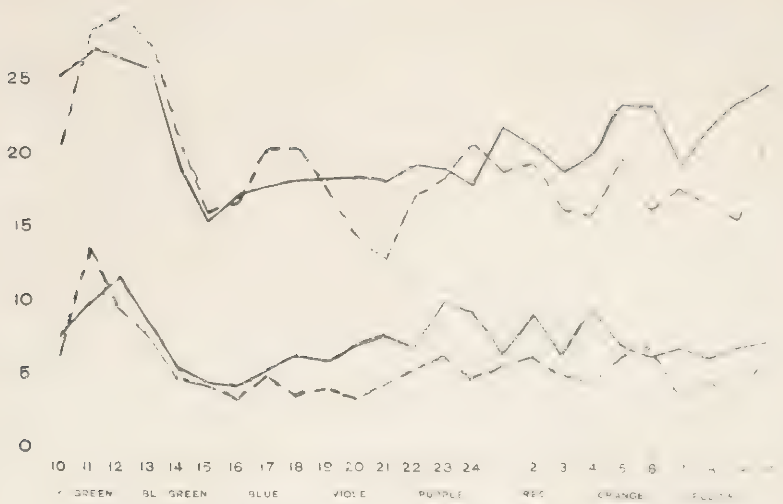


FIG. LX.—YELLOW-GREEN, 10, 11, 12

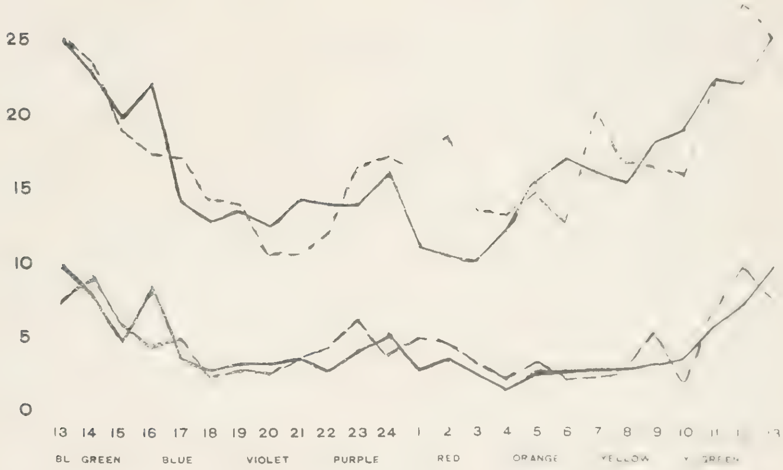


FIG. LXI.—BLUE-GREEN, 13, 14, 15

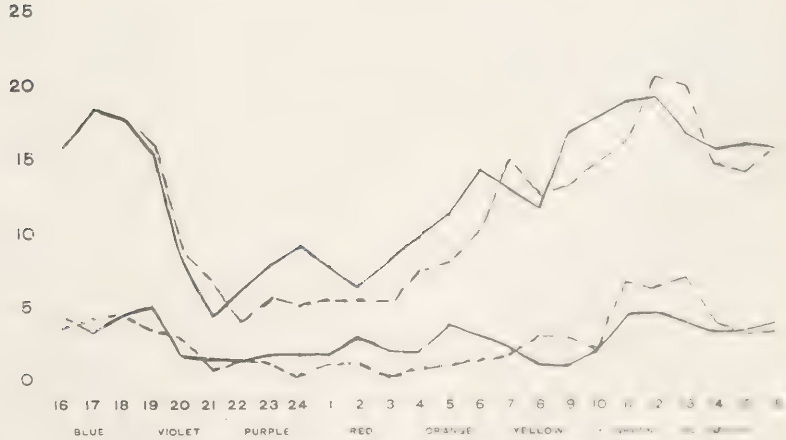


FIG. LXII.—BLUE, 16, 17, 18

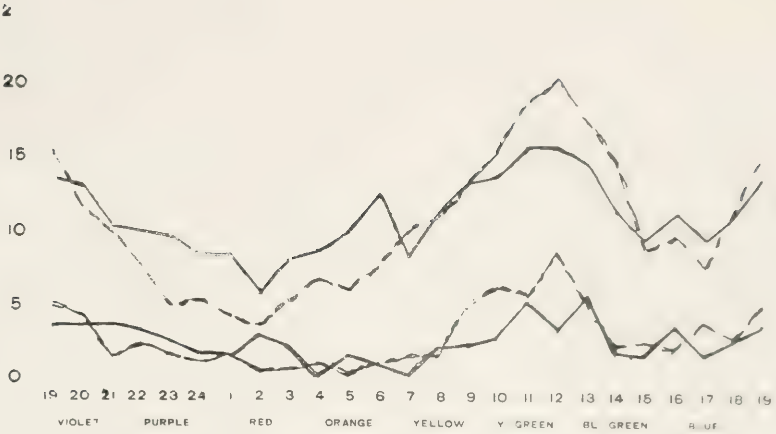


FIG. LXIII.—VIOLET, 19, 20, 21

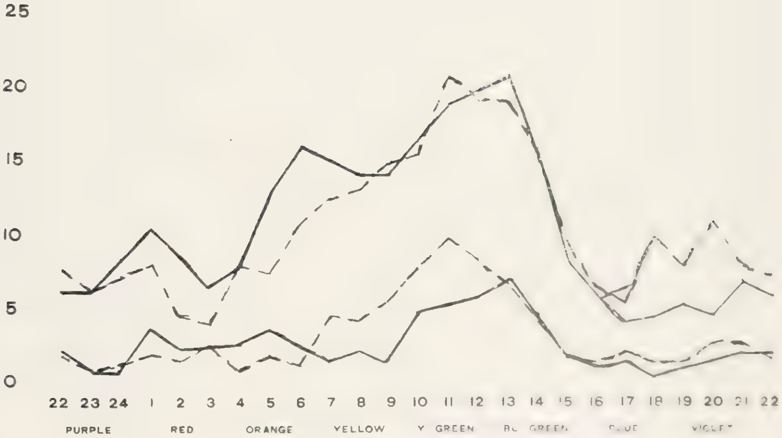


FIG. LXIV.—PURPLE, 22, 23, 24

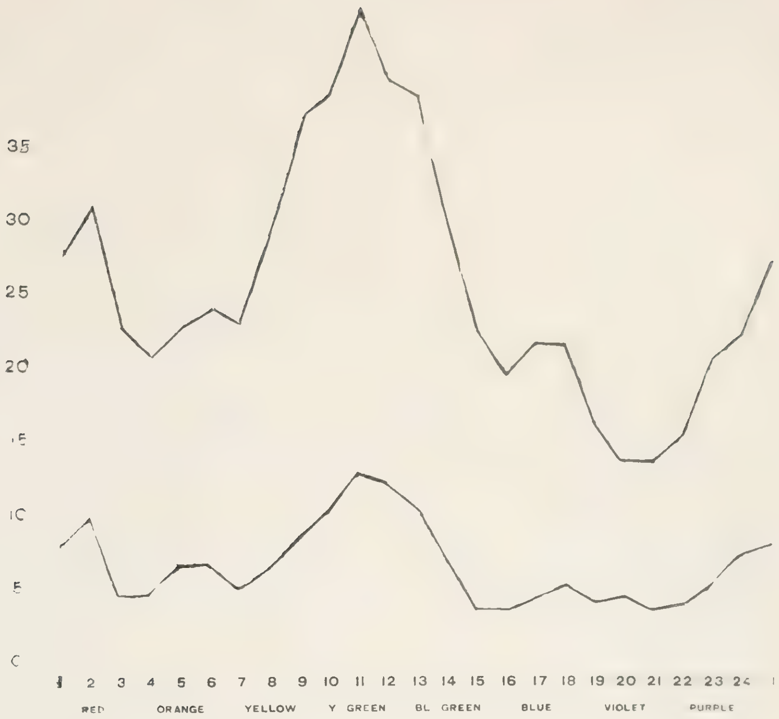


Fig. LXV.—Shades

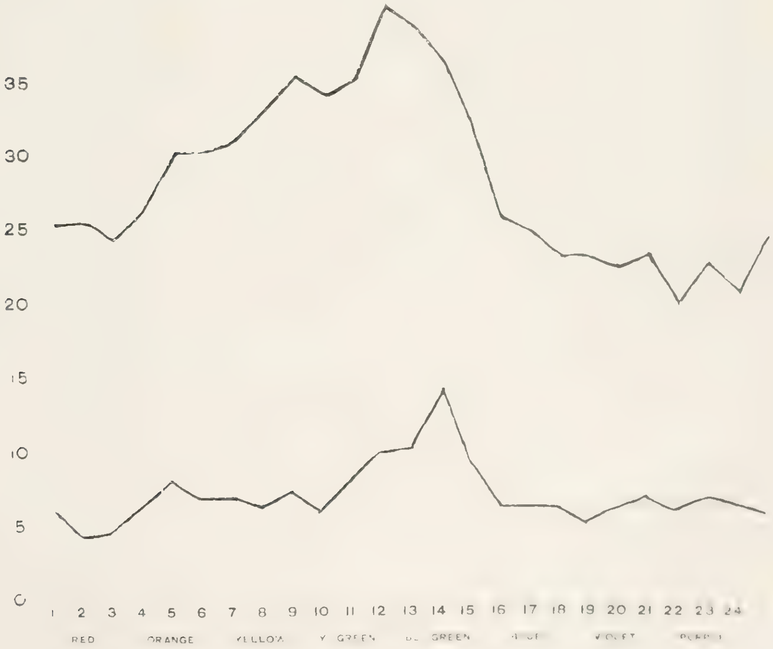


Fig. LXVI.—Tints

TOTAL CURVES

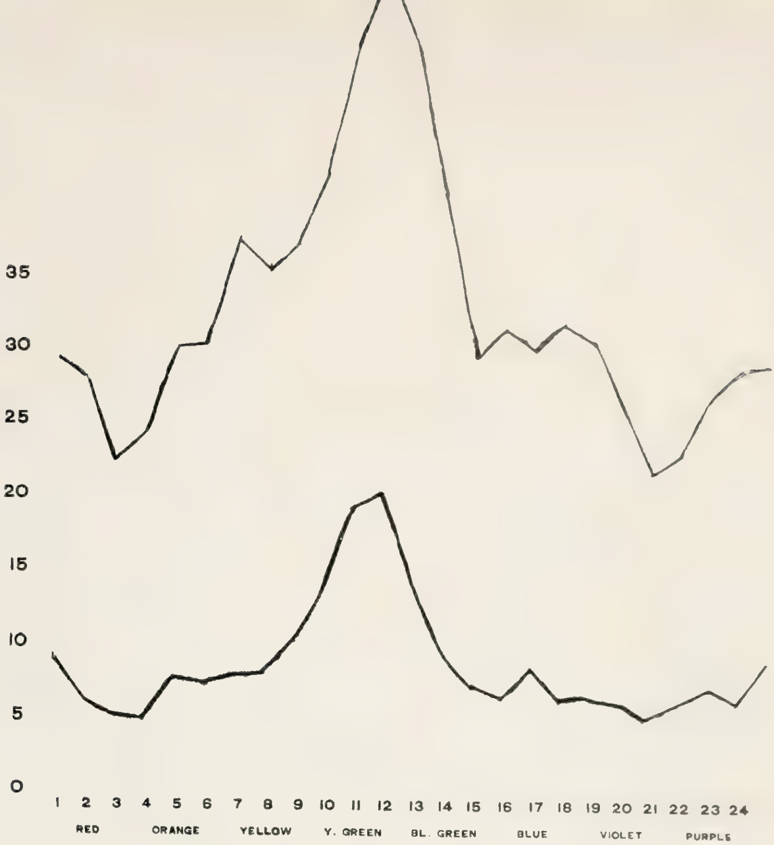
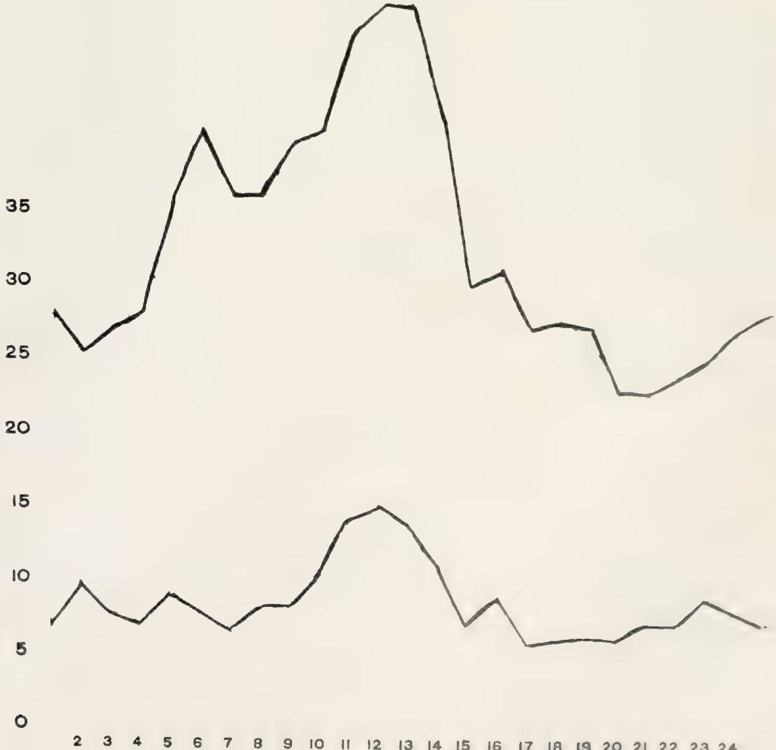


Fig. LXVII.—Shades with Tints



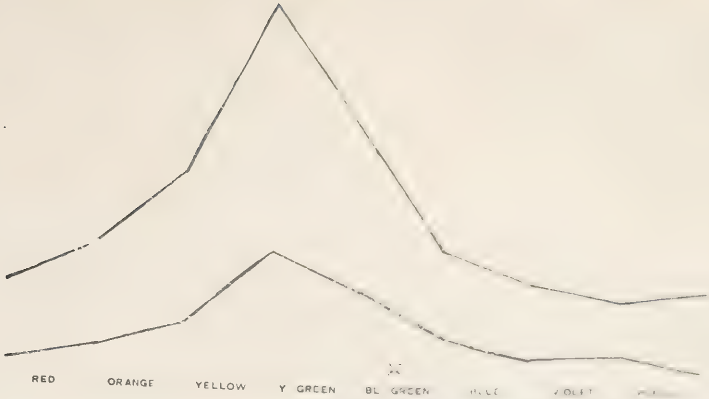


FIG. LXIX.—RED

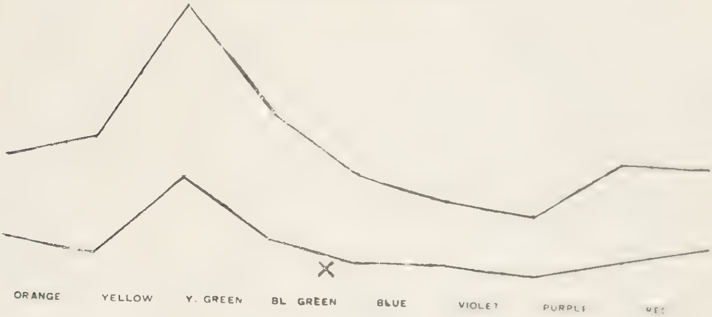


FIG. LXX.—ORANGE

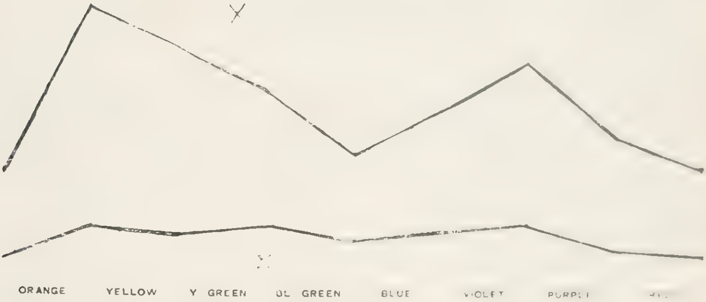


FIG. LXXI.—YELLOW

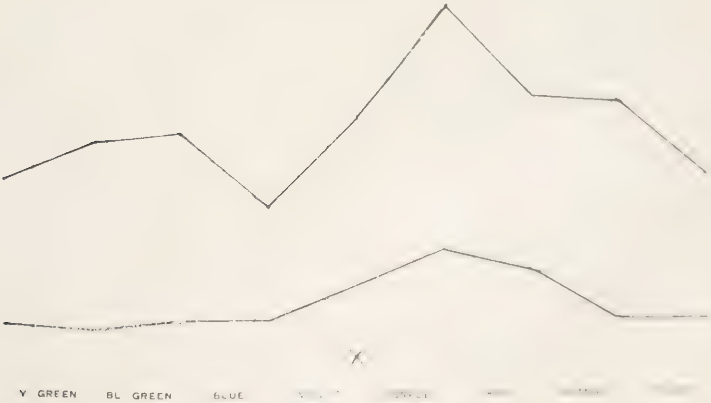


FIG. LXXII.—YELLOW-GREEN

SUMMATION CURVES—SHADES

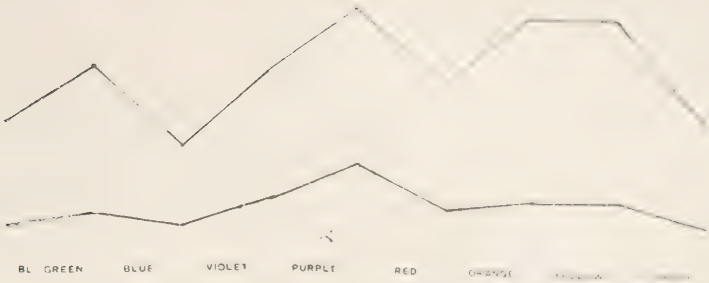


Fig. LXXIII.—Blue-Green

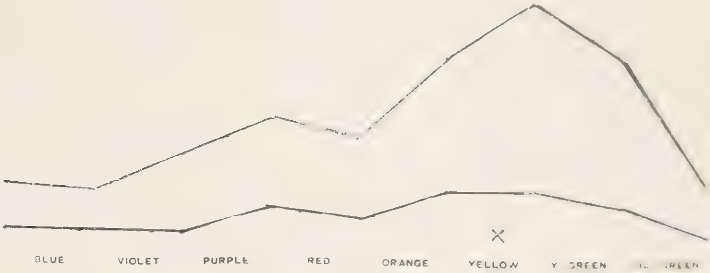


Fig. LXXIV.—Blue

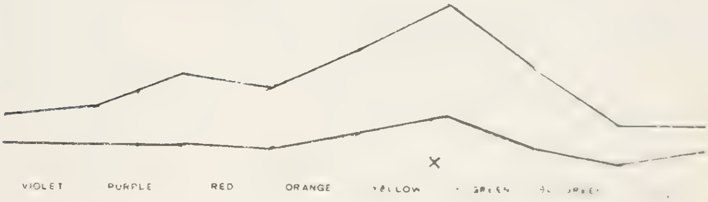


Fig. LXXV.—Violet

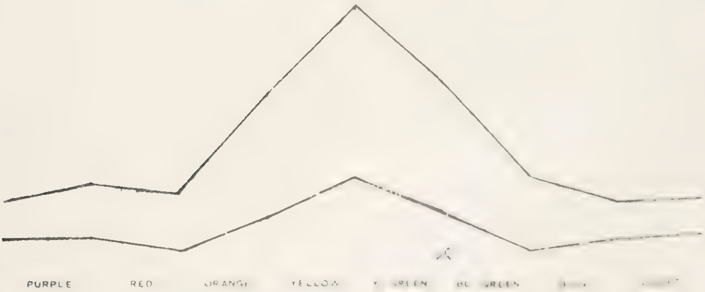


Fig. LXXVI.—Purple

SUMMATION CURVES—SHADES

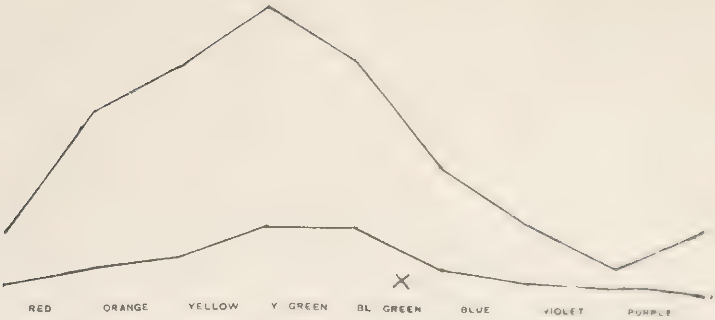


Fig. LXXVII.—Red

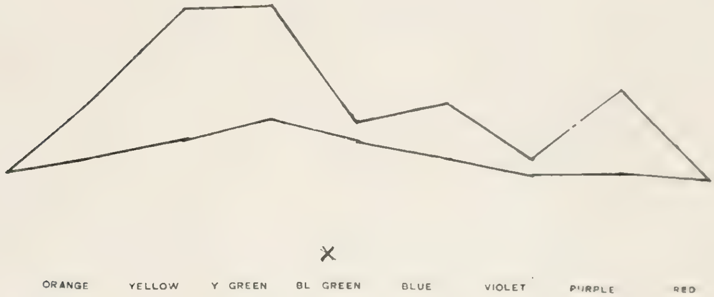


Fig. LXXVIII.—Orange

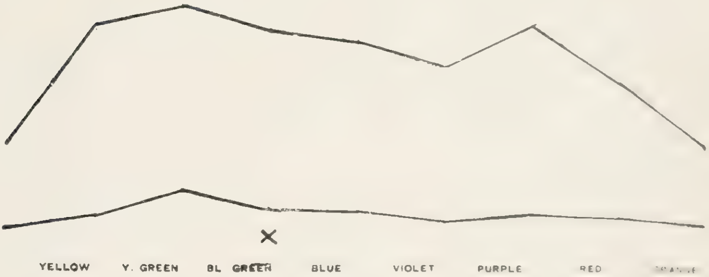


Fig. LXXIX.—Yellow

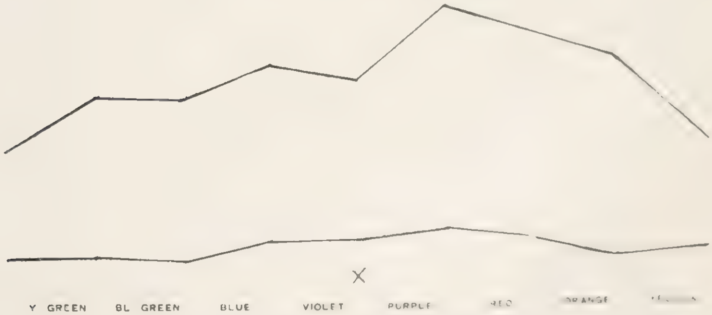


Fig. LXXX.—Yellow-Green

SUMMATION CURVES—TINTS

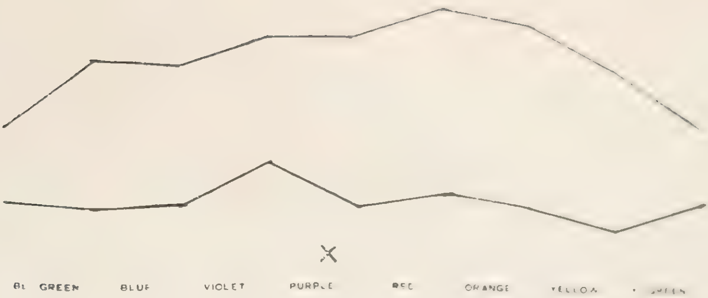


Fig. LXXXI.—Blue-Green

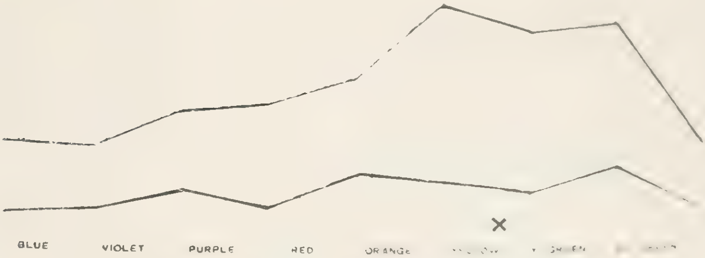


Fig. LXXXII.—Blue

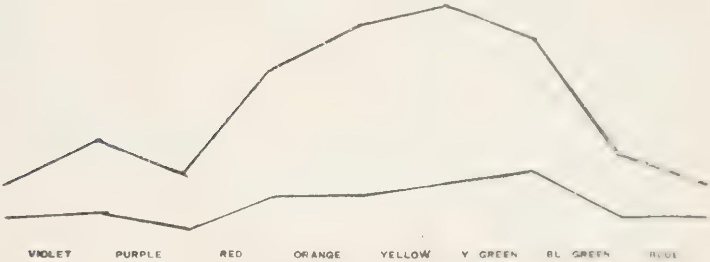


Fig. LXXXIII.—Violet

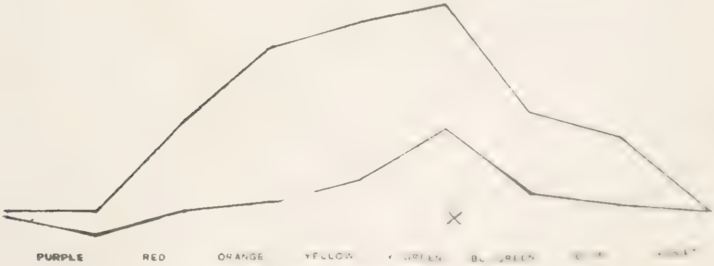


Fig. LXXXIV.—Purple

SUMMATION CURVES—TINTS

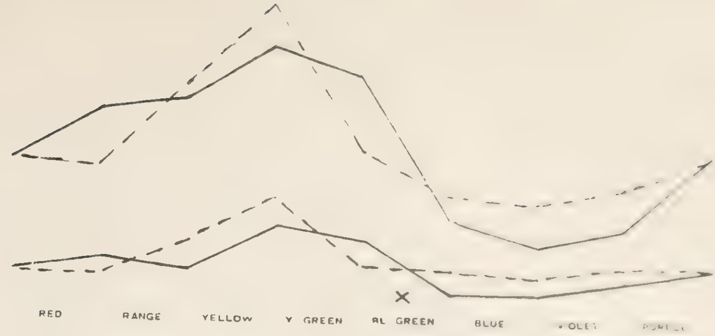


FIG. LXXXV.—RED

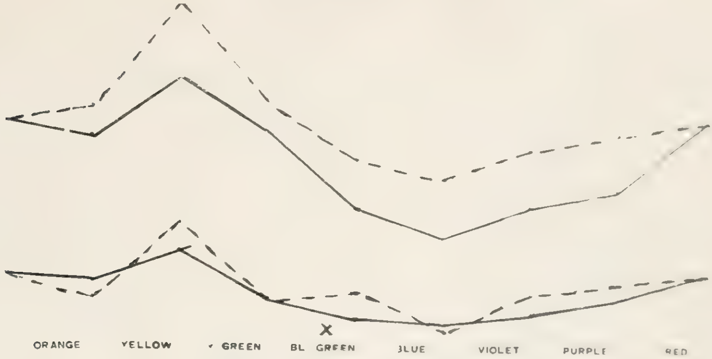


FIG. LXXXVI.—ORANGE

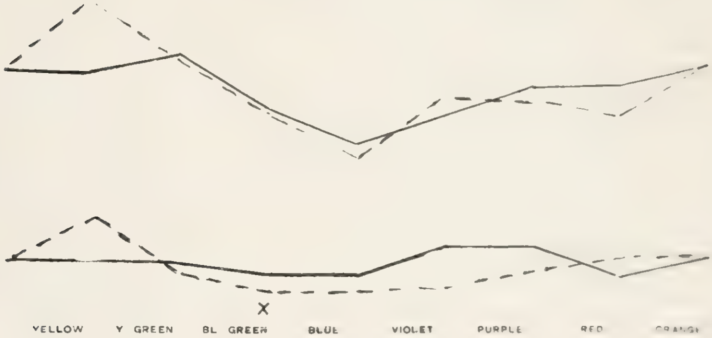


FIG. LXXXVII.—YELLOW

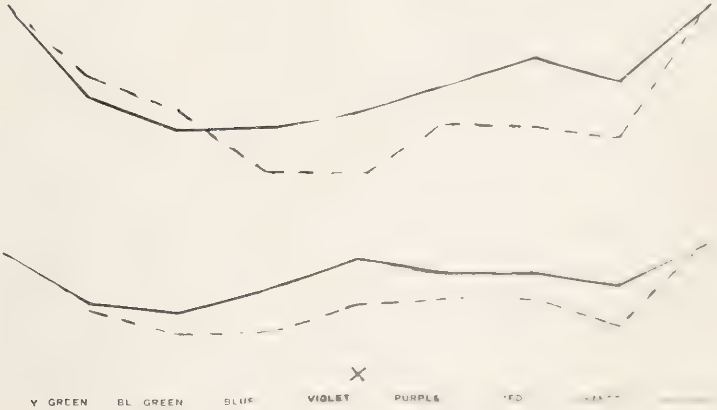


FIG. LXXXVIII.—YELLOW-GREEN

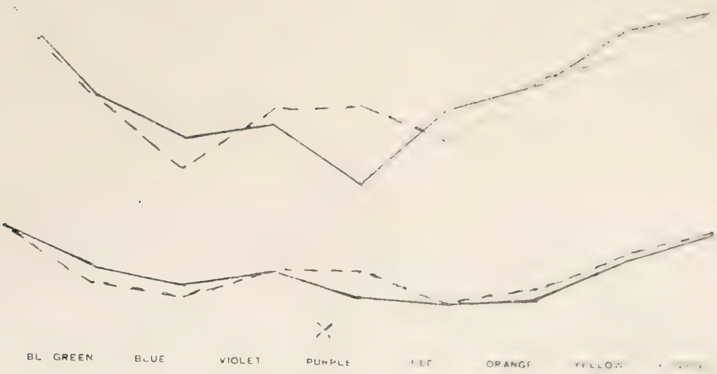


FIG. LXXXIX.—BLUE-GREEN

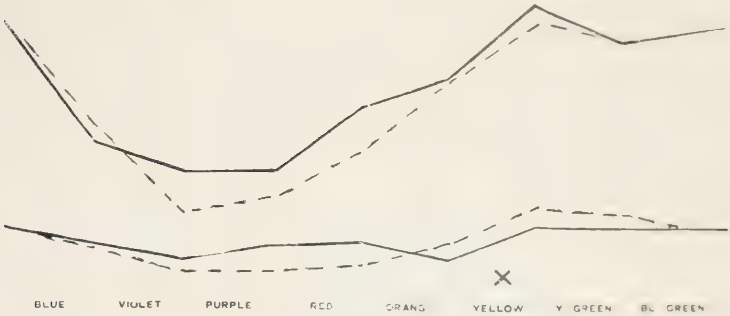


FIG. XC.—BLUE

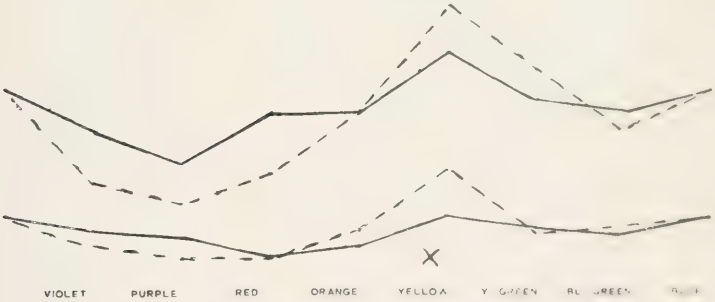


FIG. XCI.—VIOLET

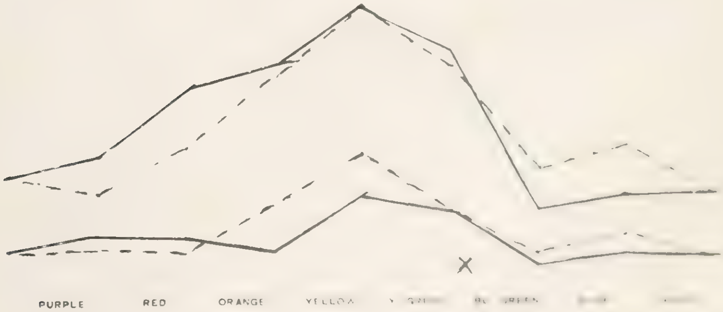


FIG. XCII.—PURPLE

SUMMATION CURVES, SHADES AND TINTS

COMPARISON OF THE FIVE SERIES

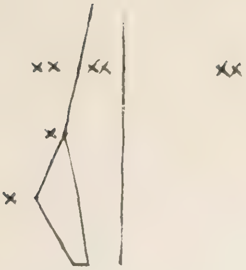


Fig. XCIII.—Red 1.

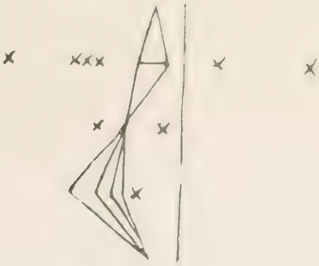


Fig. XCIV.—Red 2

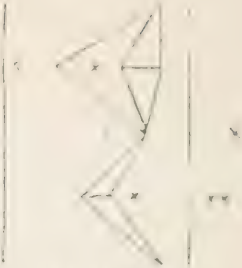


Fig. XCV.—Red 3

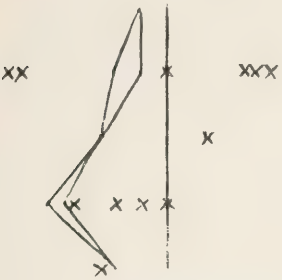


Fig. XCVI.—Orange 4.

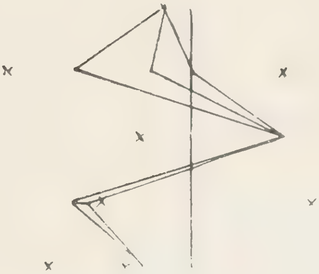


Fig. XCVII.—Orange 5.

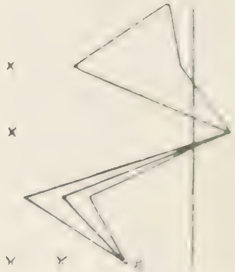
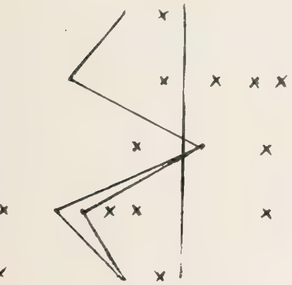


Fig. XCVIII.—Oran



g. XCIX.—Yellow 7.

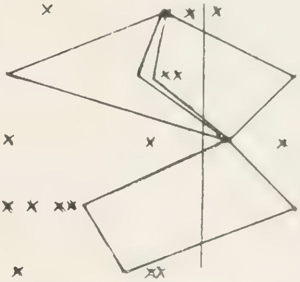


Fig. C. Yellow 8

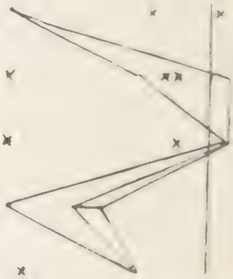
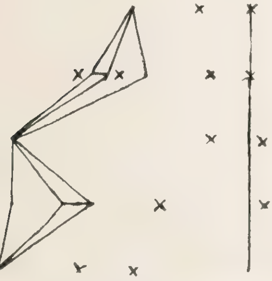


Fig. CI.—Yellow 9



g. CII.—Yel.-Green 10.

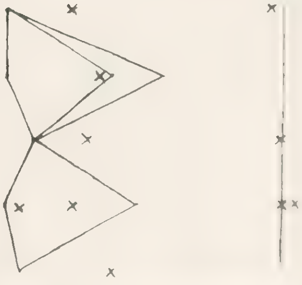


Fig. CIII. Yel. Green 11.

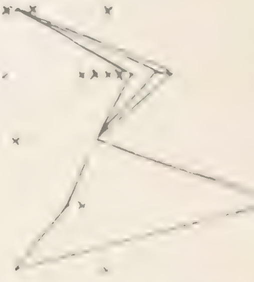


Fig. CIV. Yel. Green

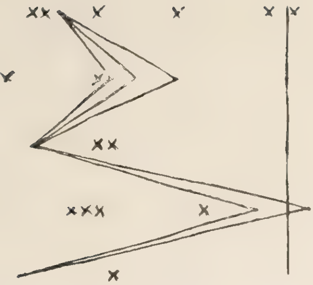


FIG. CV.—BLUE-GREEN 13.

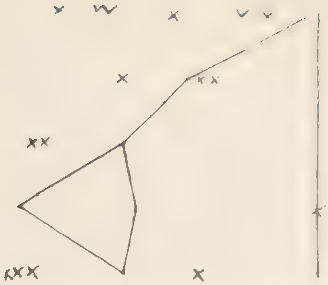


FIG. CVI.—BLUE-GREEN 14.

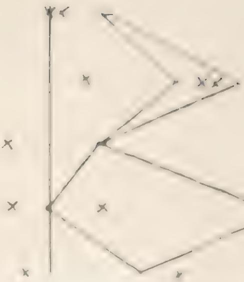


FIG. CVII.—BLUE-GREE

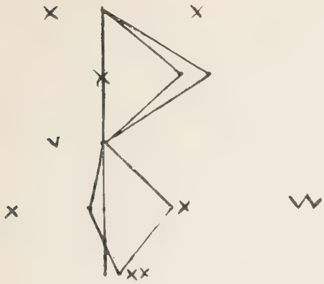


FIG. CVIII.—BLUE 16.

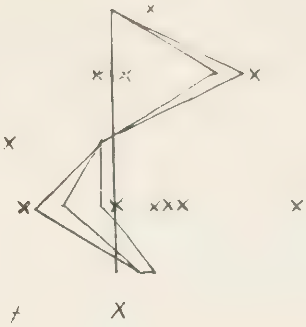


FIG. CIX.—BLUE 17.

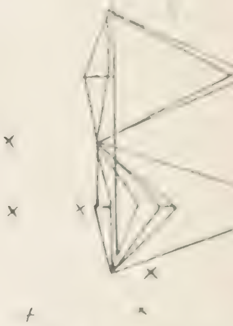


FIG. CX.—BLUE

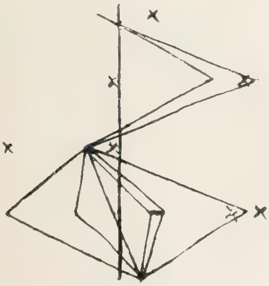


FIG. CXI.—VIOLET 19.

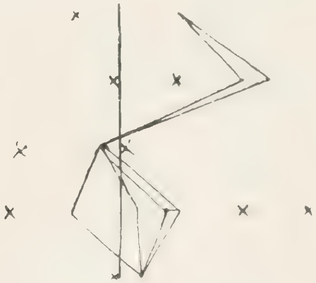


FIG. CXII.—VIOLET 20.

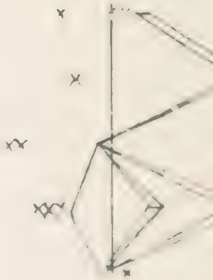


FIG. CXIII.—VIOL

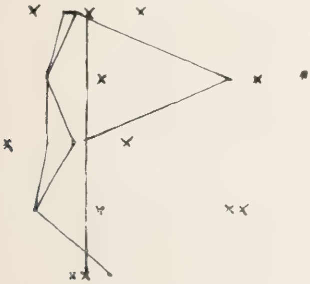


FIG. CXIV.—PURPLE 22.

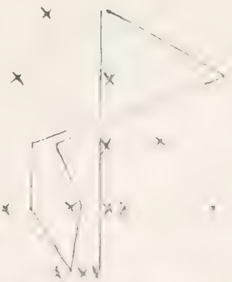


FIG. CXV.—PURPLE [illegible]

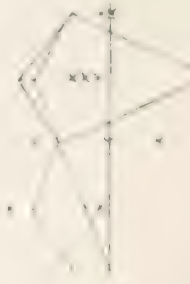
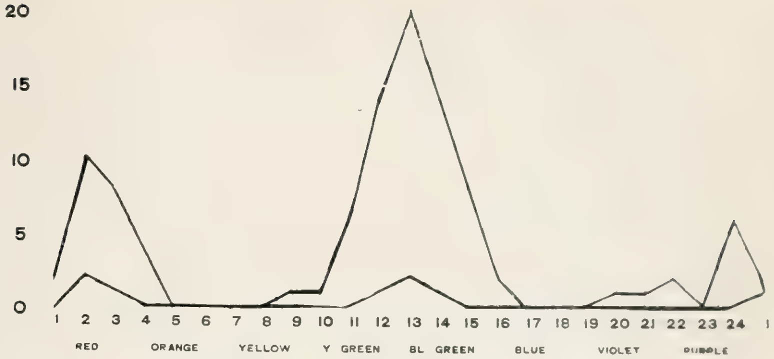
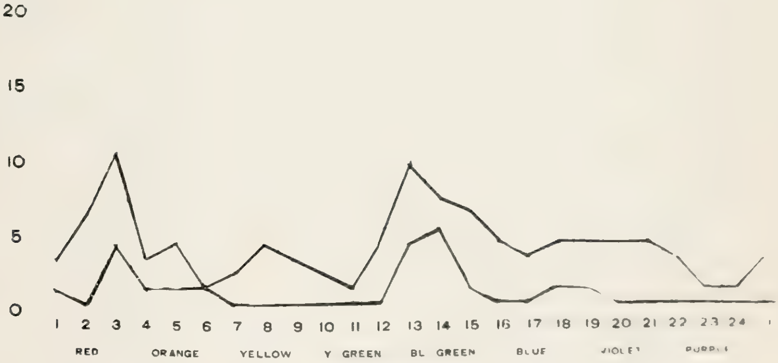


FIG. CXVI.—PUR



Abnormal A.



Abnormal B.

Fig. CXVII.

Psych
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Author Barber, Frank Louis

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